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## ISAAC NEWTON AND HIS WORK IN ASTRONOMY AND OPTICS.*

By RALPH H. CURTISS.

In March of this year we commemorated the bi-centenary of the death of Sir Isaac Newton. Sixteen years hence we shall celebrate the tercentenary of his birth. Such was the great span of Newton's life. Obviously in limited space we can touch but briefly on the brilliant achievements of that long career. However, in a journal of astronomy we can confine ourselves chiefly to Newton's optical and astronomical contributions. But these as space permits we shall hope to place in some measure in their human setting.

In this latter connection we should note at once that Newton was in no sense an infant prodigy. A posthumous child paternally, and prematurely born, he began existence a weakling so ill favored that his life was despaired of, not to mention a future. In his early school days there was no sign of the latent genius which subsequently dazzled the scientific world. His first awakening appears to have come as the result of an unprovoked fight with the boy immediately above him in Grantham school to which he was sent at the age of twelve. According to the chronicler "a severe kick in the stomach" awakened once and forever the strong spirit which carried Newton speedily to the head of the school. This story appears to be of a pattern with that of the falling apple the impact of which on Newton's head is said to have directed his thoughts to gravitation. Be that as it may, he developed at school into an observant and thoughtful lad whose mind, when not occupied with studies, was engrossed with mechanical ideas which took shape in ingenious devices such as windmills, water clocks, and sun dials. There were three of these years in Grantham School at this time, and on the whole they were years of good progress though of no great promise.

Newton experienced his second awakening when at the age of fifteen his mother called him from Grantham to the farm at Woolsthorpe, six miles away. As a result he came to realize that business occupations and farm duties were utterly distasteful to him. A passion for study de-

*Prepared for a memorial session of the University of Michigan Research Club.

Figure 1 of this paper is taken from "Splendour of the Heavens," Volume I, p. 45. The other illustrations, including Plate X, are copied from "Newton's Principia," of the edition issued in 1848 by Daniel Adee.

veloped and grew daily more absorbing while his dislike for every other occupation became more intense. It was not long before his mother wisely sent him back to Grantham School from which he entered Trinity College, Cambridge, on the 5th day of June, 1660, in the eighteenth year of his age.

In college we find Newton an eager student devoting himself to the pursuit of knowledge with amazing ardor and perseverance. An early interest in science, which may have had its beginning in the chemical experiments of an apothecary with whom he boarded at Grantham, developed into a major interest at Cambridge. Although Newton probably never lost faith in the possibilities of alchemy and devoted much time to it during his long life, he made quick work of a volume on astrology that he happened to pick up. However, this same volume was destined to exert a far reaching influence on Newton's life, for some complicated diagrams on its pages directed his attention to geometry. Following this interest he turned to Euclid but passed over it quickly because of its apparent simplicity. However, he mastered Des Cartes' *Analytical Geometry* and studied Wallis's *Arithmetic of Infinities* and Kepler's *Optics* with care, writing upon the two latter many comments. In these notes on Wallis's work was undoubtedly the germ of his method of fluxionary calculus.

Newton's progress during his undergraduate days was so swift that he outstripped his tutors in many branches of learning. Yet his acquisitions were not gotten with the rapidity of intuition. Intellectual nimbleness did not belong to him. He saw deeply and explored carefully. Then proceeding with matchless clearness and unerring sagacity he succeeded in surmounting difficulties which baffled all others.

Graduation from Cambridge at the age of twenty-two completed the preparatory period of Newton's career. Then followed a period of the same length, culminating in the publication of the *Principia* in 1687, during which all of Newton's important discoveries were made.

The external events of Newton's life during this productive period may be briefly stated. He was elected a Fellow at Cambridge in 1667, became M.A. in the following year and Lucasian Professor of Mathematics the year after that. The history of this period is chiefly concerned with the history of his successive discoveries and most of it was spent in quiet study at Cambridge.

The rest of Newton's life (1687-1727), which continued nearly as long as the other two periods together, was largely occupied with official work and studies of a non-scientific character. This third period was marked by no discoveries ranking with those made during his middle period, though some of his earlier work, such as his lunar and cometary theory, was extended and several new results of decided interest were obtained in the latter part of his life, especially before 1695 when he began active public life. Indeed we can divide Newton's career after graduation from Cambridge into two nearly equal periods of

about thirty years each. The first, from 1665 to 1695, was devoted to scientific pursuits; the second from 1695 to 1727 was occupied mainly with public duties.

Much of the first two years after Newton's graduation was spent at his rural birthplace in Woolsthorpe. Whatever two years at Woolsthorpe might mean to most nascent scientists, and much can be said for such an introspective period, they constituted for Newton perhaps the most strongly ideational interval of his whole life. To quote his own words:

"In the beginning of the year 1665, I found the method of approximating series and the rule for reducing any dignity of binomial into such a series. The same year in May I found the method of tangents of Gregory and Slusius, and in November had the direct method of Fluxions, and the next year in January had the theory of colors, and in March following I had entrance into the inverse method of fluxions. And the same year I began to think of gravity extending to the orbit of the moon, and deduced that the force which keeps the planets in their orbs must be reciprocally as the squares of their distances from the centers about which they revolve; and thereby compared the force requisite to keep the moon in her orb with the force of gravity at the surface of the earth, and found them to answer pretty nearly. All this was in the two plague years of 1665 and 1666, for in those days I was in the prime of my age for invention, and minded mathematics and philosophy more than at any time since."

It is especially notable that Newton made important beginnings in each of the fields of mathematics, optics, and astronomy during the two Woolsthorpe years. For it was in these three subjects that his preëminent scientific work was done. He also spent a great deal of time during his life on experimental work in chemistry, and in the latter half of his life devoted much thought to questions of chronology and theology. From the point of view of this paper his mathematical work concerns us only in so far as it contributed to his astronomical discovery. His optical and astronomical researches are to occupy our attention chiefly in the pages that follow.

Newton unquestionably devoted more labor to his optical than to his other discoveries and evidently took especial pride in them. But he published no connected view of these labors until 1704 when they appeared under the title of *Optics: or a Treatise on the Reflections, Refractions, Inflexions and Colours of Light.* In the year 1665 or early in the year 1666, having applied himself to the grinding of "optic Glasses of other figures than spherical" and having found the chromatic aberration an insurmountable obstacle, Newton "procured a triangular glass prism to try therewith the celebrated phenomena of colors." His experiments resulted in the grand conclusion, that light was not homogeneous, but consisted of rays, some of which were more refrangible than others. This discovery opened up a new era in the history of

optics. He saw in it the explanation of chromatic aberration but taking for granted that all transparent media produced spectra of equal length he missed the discovery of achromatism. Accordingly his attention was directed to reflecting telescopes. Thus in 1668, when he resumed his optical labors, he made with his own hands a small reflecting telescope—the first ever executed and directed to the heavens. Notwithstanding its diminutive length of only six inches, this instrument was so promising, revealing as it did the four brighter satellites of Jupiter

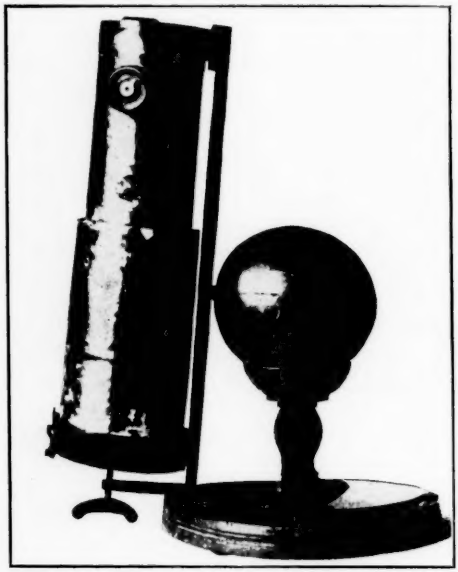


FIGURE 1.
NEWTON'S HOME-MADE TELESCOPE.
(From *Splendour of the Heavens.*)

and the moon-like phases of Venus, that its maker soon constructed a superior instrument of the same kind. The Newtonian form of reflector with a parabolic primary mirror and a diagonal flat secondary is used in practically all large reflecting telescopes of the present day. Half a century elapsed after Newton's work, however, before reflecting telescopes were made that could compete with the best refractors of the time.

When elected Lucasian Professor at Cambridge in 1669, Newton chose optics as the subject for his special weekly lectures. And through these lectures he announced results of his extensive researches on the phenomena of light. But nothing was published until 1672 when a

week after his election to the Royal Society he wrote the secretary, ". . . I am purposing them (the Society) to be considered of . . . an account of a philosophical discovery, . . . being in my judgment the oddest if not the most considerable detection which has hitherto been made into the operations of nature." This account appears in Number 80 of the *Philosophical Transactions.* In it he discusses chromatic aberration and his avoidance of the same in the reflecting telescope. He then advances his doctrine of colors in three propositions: (1) Colors are not qualifications of light, derived from refractions or reflections of natural bodies, but original and connate properties which in divers rays are divers. (2) To the same degree of refrangibility ever belongs the same color, and to the same color ever belongs the same degree of refrangibility. (3) The species of color and degree of refrangibility proper to any particular sort of rays, is not mutable by refraction nor by reflection from natural bodies, nor by any other cause, that I could yet observe. The seven different colors of the spectrum are original, or simple, and whiteness, or white light, is a compound of all these seven colors. He adds a description of the significant experiment with dispersion and composition of light in which a beam of daylight is first dispersed into a spectrum by a prism and is again united by a lens to form a white image.

The publication of these salient discoveries and experiments early in Newton's career led to a series of controversies which lasted for several years. Robert Hooke, noted English scientist, Lucas and Linus of Liege and many others either denied the truth of or criticized his experiments. Though Newton answered his objectors with great courtesy and patience the pain which his sensitive nature suffered is evident in his letter of 1676 to the secretary of the Royal Society in which he writes,

"I see I have made myself a slave to philosophy, but if I get free of Mr. Lucas's business, I will resolutely bid adieu to it (philosophy) eternally, excepting what I do for my private satisfaction or leave to come out after me; for I see a man must either resolve to put out nothing new, or to become a slave to defend it."

Fortunately Newton's courage returned in after years and he published many papers on optics in the *Philosophical Transactions.*

His discoveries concerning the inflection and diffraction of light were probably completed by 1674. Advancing upon an experiment of Grimaldi, Newton made exact measures of the diameter of the shadow of a human hair placed in a beam of sun light. He measured the fringes at different distances behind the hair and discovered that the diameters and breadths were not proportional to the distances at which they were measured. He hence supposed that the rays which passed by the edge of the hair were turned aside, as if by a repulsive force, the nearest rays suffering the greatest, the more remote a less degree of deflection. And to explain the color in the fringes he queried whether

the rays of different refrangibility did not differ in flexibility. Multiple fringes required multiple or eel like bending. But inquiries on this subject were interrupted here and were never renewed.

His theory of the colors of natural bodies which was communicated to the Royal Society in February, 1675, has been regarded as one of the profoundest of his speculations. The principles of the theory may be briefly stated. Bodies possessing the greatest refractive powers reflect the greatest quantity of light and at the confines of equally refracting media there is no reflection. The minutest particles of almost all natural bodies are in some degree transparent. Between these particles of bodies there are pores or spaces either empty or filled with media of less density than the particles themselves. These particles and pores or spaces have some definite size. Transparency exists when the particles and their pores are too small to cause reflection at their common surfaces—the light all passing through. Opacity follows when the particles and pores are sufficiently large to reflect the light which is stopped or stifled during multiple reflection. Color results because the particles according to their several sizes, reflect rays of one color and transmit those of another, the color that meets the eye being the one reflected while the other rays are transmitted or absorbed.

Analogous in origin to the colors of natural bodies, he considered the colors of thin plates or films. He was the first to determine the law of the production of these colors and to effect this discovery his mode of procedure was most ingenious. He placed a convex lens of large known radius of curvature on an optically flat surface. Thus from the point of contact at the center, to the circumference of the lens, he obtained between the glass surfaces a film of air or other substance of thickness known and increasing from zero to a considerable thickness at the edge. Newton measured with nicest accuracy the thickness at which the bright rings were produced when light was reflected from this device. To explain these interference rings he invented his theory of "fits of easy reflection and transmission" of light based upon the corpuscular theory. He regarded light as consisting of small material particles or corpuscles emitted from incandescent bodies. These corpuscles possess, at equally distant intervals, dispositions or fits to be reflected from or transmitted through the surfaces of bodies on which they fall thus accounting for the interference rings noted above. Somewhat strikingly, but fortuitously, in keeping with modern theory he thought that matter and light were convertible into one another.

Newton proposed his views on the nature of the ether in a paper entitled *An Hypothesis Explaining Properties of Light,* dated December, 1675. He rejected these views later but finally resumed them permanently and stated them at the very end of the *Principia.* He considered the ether to be a most subtle spirit which pervades all bodies and is expanded through all the heavens. It is electric and almost, if not quite, immeasurably elastic and rare. By the force and action of this

spirit the particles of bodies mutually attract one another, at near distances, and cohere, if contiguous; and electric bodies operate at greater distances, as well repelling as attracting the neighboring corpuscles; and by the action of this ether light is emitted, reflected, refracted, inflected, and heats bodies. The ether then was a convenient medium invented to assist in the explanation of many observed phenomena for which known laws and theories failed to account.

As we review Newton's accomplishments in the field of optics it is interesting to speculate on the possibilities that would have followed if he had approached this subject on the basis of the undulatory theory or if he had not missed by so narrow a margin the detection of the variation of dispersion in different glasses or had narrowed his circular aperture to a slit when studying spectra. In his hands these things that lay at his fingers' ends would surely have been brought to a stage which others reached only after many decades. However, in such speculation we must not lose sight of the progress he actually made. His construction of the first reflecting telescopes and his discovery of the action of a prism on white light were notable achievements. Further his many experiments, theories, discoveries, and inventions in optics, some of which like the sextant were not published until after his death, stimulated, inspired and directed the work of others in no small degree.

Turning now to Newton's discoveries in astronomy we find ourselves again at Woolsthorpe in the summer of 1666, the twenty-fourth year of his life, the year following his graduation from Cambridge. The setting is that of Voltaire's plausible and popular story of the falling of the apple. A refugee from the plague, Newton is free to meditate on the problems to whose explication Ptolemy, Copernicus, Tycho, Galileo, and Kepler have recently contributed but for which no solution has been found. Copernicus has corrected Ptolemy's solar system by placing the sun at the center. Galileo has made the telescopic observations that have established the system of Copernicus, and has achieved such progress in the study of motion and the action of forces that he has earned his title as the founder of dynamics. Tycho has made the measurements of the planets which have enabled Kepler to derive his laws of planetary motion. And in these laws Newton is about to see the key to the dynamical solution of the problem of the solar system. The *Almagest* and the *De Revolutionibus,* in Newton's time the two most important writings in astronomical literature, are at hand but the world is waiting for the greater work, the *Principia.*

Even as early as this in his career the nature of the mysterious power which causes all bodies to descend toward the center of the earth had dawned upon Newton. Since from the bottoms of the deepest caverns to the summits of the highest mountains, this power suffered no sensible change, its action might reasonably extend to the moon. If so such a force might be sufficient to retain that body in its orbit about the earth. But though this power suffered no variation that was measur-

able by methods of Newton's day at different altitudes on the earth's surface yet at the distance of the moon it might undergo more or less diminution. To investigate the law of this diminution Newton turned to the planets and was able to show "that the motions of the planets, regarded as moving in circles, and in strict accordance with Kepler's third law, could be explained as due to the action of the sun, if the sun were supposed capable of producing on a planet an acceleration toward the sun itself which is proportional to the inverse square of its distance from the sun."

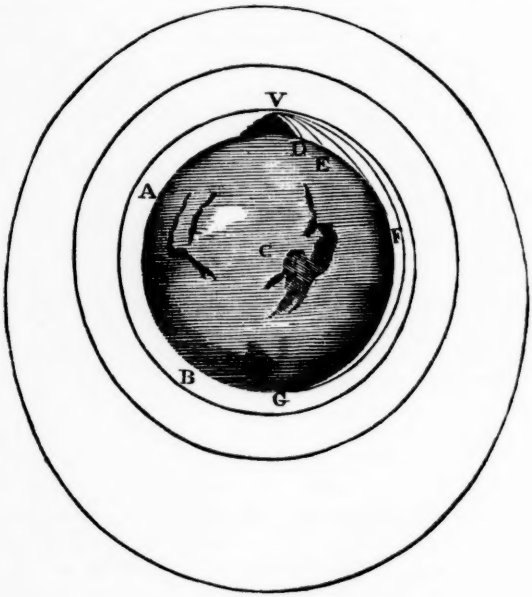



FIGURE 2.
TRAJECTORIES AND ORBITS.
(From Newton's *System of the World.*)

The next step in Newton's investigation was to consider whether the motion of the moon around the earth could be explained by the force of the earth's gravity operating according to this law of inverse squares. Was such a force emanating from the earth and directed to the moon sufficient to balance the centrifugal tendencies of that body and hold it in its orbit? To ascertain this master fact he compared the space through which heavy bodies fall in a second of time at the earth's surface with the space through which the moon falls toward the earth in the same time in the course of its motion in an orbit assumed to be circular. Not having available at Woolsthorpe the value of the earth's

circumference of Snell and Norwood, Newton appears to have assumed the value of 60 miles to the degree or 21,600 miles as used among geographers and navigators. He found on this basis that whereas the moon in its orbital motion actually deviated 13 feet each minute toward the earth, his computed value from the law of gravitation was two feet per minute greater. Possibly this result did not answer his expectations or perhaps he mistrusted it because he had assumed without sure grounds that the distance between the earth and moon could be taken as the distance between their centers. However this may be, he laid the subject aside for some years and devoted himself chiefly to optics and mathematics.

It was not until 1679 that a letter of Robert Hooke's to Newton, dealing among other things with the path of a falling body referred to the earth's center, corrected an error that Newton had made and stimulated him to continue his study of celestial motions. In the course of these studies Newton showed "that if a moving body revolves about a central mass in such a way that the line joining the two bodies describes equal areas in equal times, as in Kepler's second law of planetary motion, then the moving body is acted on by an attraction directed exactly toward the central body; and further that if the path is an ellipse with the central body in one focus, as in Kepler's first law, then this attraction must vary as the inverse square of the distance between the two bodies." Thus Kepler's well known empirical laws of planetary motion were shown to lead necessarily to the conclusions that the sun exerts on a planet an attraction inversely proportional to the square of the distance of the planet from the sun and that such an attraction affords a sufficient explanation of the motion of the planets. But again, Newton published nothing and "threw his calculations by, being upon other studies."

Three years later, in January 1682, at a meeting of the Royal Society, Newton's attention was directed to Picard's measurement of a degree of the meridian. He took a memorandum of the result and, afterward, at the earliest opportunity, having computed from it the diameter of the earth, he resumed his calculation of the motion of the moon which had led to a disappointing result in 1666. As he proceeded therein he foresaw that his early expectations were now likely to be realized. The story goes that the prospect overpowered him. He became unable to continue the calculation and entrusted its completion to a friend. The discrepancy in results, which Newton had apparently regarded as incompatible with his conjecture in 1666, was now so completely removed that he considered his hypothesis as to the law of gravitation fully established.*

We come now to the events which led directly to the publication of

*This account of the verification has been questioned.

Newton's great work, the *Philosophiae Naturalis Principia Mathematica.* It is stated that Newton composed a series of twelve propositions on planetary motions and sent them to the Royal Society late in 1683. Whether these became known or not it is on record that in August, 1684, the astronomer, Halley, visited Cambridge to consult Newton on the problem of the motion of a planet around the sun under solar attraction diminishing as the square of the distance. Apparently to Halley's surprise Newton stated at once that such a planetary orbit would be an ellipse. Pressed for his reasons he claimed to have demonstrated this result. But the calculation was lost and in the attempt to reproduce it he fell into error and produced a different result. Soon the error was corrected and in the following November a copy of the demonstration was sent to Halley. Fortunately at this time Newton's attention was not diverted to other studies; he solved at once a number of other problems on motion and devoted his usual autumn course of university lectures at Cambridge to this subject. By the following February there had been registered in the books of the society, in order to "secure the invention," a "curious treatise" by Newton called *Propositiones De Motu.* This treatise was the germ of the *Principia* and was obviously meant to be a short account of what that book was intended to embrace. It occupies twenty-four octavo pages and consists of four theorems and seven problems, some of which are identical with some of the most important propositions of the second and third sections of the first book of the *Principia.*

The years 1685 and 1686 will ever be memorable in the history of science for it was in them that Newton composed almost the whole of his great work, the *Principia.* On the twenty-eighth of April, 1686, he presented and dedicated to the Royal Society the first volume. So important was this volume considered that the Society undertook its publication. But awkward delays arose and finally it fell to Newton's faithful friend, Halley, who had encouraged and at some stages even induced Newton to compose the work, to finance the publication himself. The second book was ready in the autumn of 1686 and the third in April of the following year; and the whole work was published about the middle of the year 1687, under the title, *Philosophiae Naturalis Principia Mathematica.*

The *Principia,* to use the common appellation, consists of three books besides certain important introductory pages. The first book deals generally with problems of motions, solved for the most part without special reference to astronomy; the second deals with the motions of bodies through resisting media and is of comparatively little astronomical importance; the third book deals more directly with the motions of celestial bodies and with the tides, explained on Newton's and Galileo's dynamical principles. The *Principia* is written in the form of propositions liberally amplified by corollaries, lemmae, theorems, and scholia. To the *Principia* proper may well be joined *"The System of the World,"*

which states chiefly in expository form the author's conclusions respecting the attractive forces, motions, diameters, densities, and masses of bodies in the solar system, with especial reference to the moon; the distances and motions of comets and the nature and origin of their tails; the nature and distances of the stars; the phenomena of the tides and their bearing on the attractive forces of the sun and moon.

The introductory portion of the *Principia* contains the first coherent statement of the basic laws according to which the motions of bodies are produced or changed. Galileo was the first to state the law that a body in motion continues to move in the same direction and at the same speed unless some external cause produces a change in this motion. Newton restated and adopted this rule as the first of three fundamental laws of motion. Galileo was also the first to observe that falling bodies all descend with the same uniform acceleration. Newton extended this idea to the moon and planets which were falling in the sense that they possessed central acceleration toward the earth or sun and he accepted the general idea of Galileo that acceleration in a body's motion could be taken as a measure of the effect produced by one body on another or the measure of force acting upon such a body. This idea is incorporated in his second law of motion.

A further important step was taken by Newton when he added to the study of motions the conception of *mass*. The ordinary process of weighing a body in a balance is a method of measuring masses; for weight is proportional to mass as Newton showed by many very accurate pendulum experiments. But he went further and recognized mass as the quantitative aspect of inertia. The really important step was the distinct recognition of mass as a property of all bodies—a property dynamically fundamental and measurable.

A further principle of outstanding importance, of which little was known before Newton's day, was given by him as the Third Law of Motion in the words, "To every action there is always opposed an equal reaction." This principle is employed when we are concerned with the motion of two or more bodies subject to their mutual attractions. The law specifies that if one body acts upon another at any distance, the second reacts on the first with an equal and oppositely directed force. Newton made several experiments to verify this law, such as measuring the rebounds from the impacts of elastic bodies, and observing the accelerations of magnets floating in basins of water.

[*To be continued.*]

# THE VIIth SERIES OF THE ATLAS STELLARUM VARIABILIUM.

By J. G. HAGEN, S. J.

The VIIth Series of the A.S.V. is a continuation of the VIth Series, in the sense that it contains variables whose observation requires instruments of at least 9 inches aperture.

This Series was commenced in 1900 with the 12-inch refractor of the Georgetown University but was discontinued by my transfer to Rome.

During the work on the Astrographic Catalogue it became evident that the chronograph used in the preceding series should be replaced by the more convenient astrograph. So, when the Vatican Section of that Catalogue was finished, I returned to the A.S.V.

The VIIth Series contains 55 variables on 41 charts. The table here published has a triple purpose: first, to indicate which stars make up the forthcoming Series; second, to prove that the variables are truly identified; third, to give a means of testing the periods of these variables by the magnitudes observed many years ago. It will be seen that the observations for the most part were made at Georgetown.

JULIAN DAY (—2400000), AND MAGNITUDES.

<mag. means *fainter*, >mag. means *brighter*.

V CAMELOP.
054974

| | M |
|---|---|
| 16048 | <12.0 |
| 074 | <12.0 |
| 161 | <12.0 |
| 401 | <12.0 |
| 408 | <12.0 |
| 427 | 12.0 |
| 462 | 12.0 |
| 800 | 9.6 |
| 17167 | <12.0 |
| 210 | 12.0 |
| 17229 | <12.0 |
| 23831 | <14½ |
| 840 | <14½ |
| 23855 | <14½ |

Z PUPPIS
*072820b*

| | |
|---|---|
| 15832 | 10.8 |
| 16133 | 9.8 |
| 166 | 10.4 |
| 200 | <11.0 |
| 471 | <11.0 |
| 17217 | <10.0 |
| 229 | 11.2 |
| 17259 | <11.2 |
| 23856 | 10.3 |
| 23857 | 10.1 |

X PUPPIS
*072820a*

| | M |
|---|---|
| 15832 | 8.2 |
| 16200 | 8.5 |
| 23856 | 8.3 |
| 23857 | 8.5 |

RV VIRGINIS
*130212*

| | |
|---|---|
| 15498 | 11.6 |
| 540 | 12.2 |
| 852 | 12.0 |
| 878 | <12.0 |
| 16194 | <12.0 |
| 16233 | <12.0 |
| 24298 | <14½ |
| 24299 | <14½ |

Z BOOTIS
140113

| | |
|---|---|
| 15832 | 10.3 |
| 885 | <11.3 |
| 16193 | <11.3 |
| 16233 | <11.3 |
| 24299 | 12.0 |
| 302 | 12.1 |
| 24313 | 12.4 |

Y LIBRAE
*150605*

| | M |
|---|---|
| 24302 | (14+) |
| 313 | (14+) |
| 24315 | (14½) |

RZ SCORPII
*155823*

| | |
|---|---|
| 23948 | 8.7 |
| 953 | 8.7 |
| 954 | 8.8 |
| 955 | 8.9 |
| 23961 | 9.0 |

RR OPHIUCHI
*164319*

| | |
|---|---|
| 15944 | 8.7 |
| 966 | 9.4 |
| 16281 | 10.5 |
| 24973 | <13½ |
| 986 | <13½ |
| 25314 | <13½ |

RV HERCULIS
165631

| | |
|---|---|
| 15615 | 12.1 |
| 619 | 12.0 |
| 864 | <12 |
| 903 | <12 |
| 978 | 9.9 |
| 16284 | <12 |

RV HERCULIS
165631

| | M |
|---|---|
| 23321 | <14 |
| 986 | 10.4 |
| 23988 | 10.5 |

RT HERCULIS
170627

| | |
|---|---|
| 15625 | 9.4 |
| 879 | 10.3 |
| 899 | 9.7 |
| 16284 | 11.2 |
| 24004 | 12.6 |
| 24005 | 12.4 |

RY HERCULIS
175519

| | |
|---|---|
| 15625 | <12 |
| 918 | <12 |
| 978 | 8.6 |
| 16297 | <12 |
| 24008 | 11.4 |
| 24016 | 11.3 |

V DRACONIS
175654

| | |
|---|---|
| 15625 | <12 |
| 879 | <12 |
| 903 | <12 |
| 978 | <12 |
| 16297 | 11.3 |
| 24059 | 12.2 |

JULIAN DAY (—2400000), AND MAGNITUDES.

UW DRACONIS
175554

| | M |
|---|---|
| 24058 | > 7½ |

W DRACONIS
180565

| | |
|---|---|
| 16003 | 10.7 |
| 063 | <11 |
| 303 | <10 |
| 16370 | <11 |
| 24067 | 11.2 |
| 24074 | 11.3 |

X DRACONIS
180666

| | |
|---|---|
| 16003 | 11.2 |
| 063 | 11.0 |
| 16370 | 10.8 |
| 23067 | <13 |
| 074 | 12.1 |
| 23080 | 11.7 |

W LYRAE
181136

| | |
|---|---|
| 15626 | 9.0 |
| 885 | <11 |
| 908 | <11 |
| 16303 | <12 |
| 24026 | > 8 |
| 24034 | > 8 |

SS SAGITTARII
*182416*

| | |
|---|---|
| 15953 | 9.1 |
| 986 | 8.9 |
| 16317 | 9.1 |
| 24007 | 9.4 |
| 24012 | 9.4 |

RZ HERCULIS
183225

| | |
|---|---|
| 15626 | <12 |
| 925 | 11.5 |
| 978 | <12 |
| 16303 | <12 |
| 23711 | 12.4 |
| 721 | 11.9 |
| 24028 | 13.4 |

Z LYRAE
185634

| | |
|---|---|
| 15633 | 10.7 |
| 945 | 10.7 |
| 16303 | <11 |
| 24034 | <13½ |
| 041 | <13½ |
| 24048 | <13½ |

RT LYRAE
185737

| | |
|---|---|
| 16004 | <12 |
| 054 | <12½ |
| 16303 | <12½ |
| 24049 | 12.4 |
| 24050 | 12.7 |

V LYRAE
190529a

| | M |
|---|---|
| 14814 | <12 |
| 897 | 12.3 |
| 15586 | <12 |
| 978 | <12 |
| 16303 | <12 |
| 24052 | <13½ |
| 24473 | 13.8 |

VZ LYRAE
190529b

| | |
|---|---|
| 24473 | 10.6 |

RW SAGITTARII
*190819a*

| | |
|---|---|
| 14874 | 8.8 |
| 898 | 8.9 |
| 15651 | 9.4 |
| 986 | 9.9 |
| 16317 | 10.1 |
| 23703 | 10.1 |
| 705 | 10.1 |
| 23713 | 10.1 |

BH SAGITTARII
*190818a*

| | |
|---|---|
| 23705 | 12.8 |

RX SAGITTARII
*190818b*

| | |
|---|---|
| 14854 | <11½ |
| 874 | <11½ |
| 898 | <11½ |
| 15587 | <11½ |
| 15969 | <11½ |
| 23705 | 12.7 |

S LYRAE
190925

| | |
|---|---|
| 14814 | 11.1 |
| 825 | 10.4 |
| 898 | 11.5 |
| 15586 | <11½ |
| 16318 | <11½ |
| 24063 | 11.8 |
| 24064 | 11.8 |

W AQUILAE
*191007a*

| | |
|---|---|
| 15651 | 10.5 |
| 945 | <11 |
| 16318 | <12 |
| 24016 | 9.5 |

TY AQUILAE
*191007b*

| | |
|---|---|
| 15651 | 10.6 |
| 15945 | 10.5 |
| 24016 | 10.4 |

RS LYRAE
190933a

| | M |
|---|---|
| 15944 | <10½ |
| 16042 | <10½ |
| 16318 | <10½ |
| 24394 | <14 |
| 395 | <14 |
| 24407 | <14 |

WW LYRAE
190933b

| | |
|---|---|
| 24407 | 13.4 |

RU LYRAE
190941

| | |
|---|---|
| 16032 | <13½ |
| 074 | <12 |
| 16318 | <12 |
| 23507 | 10.9 |
| 23509 | 10.9 |

U DRACONIS
190967

| | |
|---|---|
| 15653 | <12 |
| 945 | <12½ |
| 16318 | <12½ |
| 23708 | 9.4 |
| 710 | 9.0 |
| 23722 | 9.8 |

TZ CYGNI
191350

| | |
|---|---|
| 15943 | 10.1 |
| 16042 | 9.9 |
| 16318 | 10.0 |
| 23075 | 10.4 |

U LYRAE
191637

| | |
|---|---|
| 15659 | 8.8 |
| 946 | 9.1 |
| 16321 | 10.7 |
| 24412 | 9.2 |

UZ LYRAE
191737

| | |
|---|---|
| 15659 | 9.9 |
| 15946 | 10.1 |
| 24412 | 10.1 |

TY CYGNI
192928

| | |
|---|---|
| 15946 | <10 |
| 16042 | 9.2 |
| 16321 | (10) |
| 24393 | 9.0 |
| 394 | 9.1 |
| 24407 | 9.0 |

RT AQUILAE
193311

| | M |
|---|---|
| 15658 | <11 |
| 15947 | <11 |
| 24365 | (12) |
| 366 | 11.9 |
| 24369 | 11.9 |

SV AQUILAE
193411

| | |
|---|---|
| 15658 | <11 |
| 15947 | <11 |
| 24369 | <13½ |

RV AQUILAE
193509

| | |
|---|---|
| 15948 | 9.3 |
| 16015 | <11 |
| 16321 | <11½ |
| 23712 | <13½ |
| 722 | <13½ |
| 23729 | <13½ |

RT CYGNI
194048

| | |
|---|---|
| 23703 | > 8½ |
| 705 | 8.4 |
| 23706 | 8.6 |

TU CYGNI
194348

| | |
|---|---|
| 15338 | 9.0 |
| 589 | 10.1 |
| 16321 | <11½ |
| 23703 | 9.1 |
| 705 | 9.2 |
| 23706 | 9.1 |

No. 13 CYGNI

| | |
|---|---|
| 23705 | 10.4 |
| 706 | >10½ |
| 23108 | 10.1 |

X AQUILAE
194604

| | |
|---|---|
| 14814 | 10.1 |
| 827 | 10.2 |
| 902 | (11) |
| 15587 | <11 |
| 16321 | <11 |
| 24363 | <13½ |
| 364 | <13½ |
| 24368 | <13½ |

RR AQUILAE
*195202*

| | |
|---|---|
| 14820 | <11½ |
| 854 | <11½ |
| 15952 | <11½ |
| 969 | <11½ |
| 16321 | <11½ |
| 24024 | 10.1 |

JULIAN DAY (—2400000), AND MAGNITUDES.

| RS AQUILAE 195308 | M | ST CYGNI 202954 | M | UY CYGNI 205230 | M | UZ CYGNI 215543 | M |
|---|---|---|---|---|---|---|---|
| 15652 | <11 | 15684 | <12 | 23729 | 11.4 | 16437 | <10½ |
| 986 | <11 | 719 | 11.1 | 739 | 11.3 | 16460 | <10½ |
| 16321 | (11) | 987 | <12 | 758 | 11.2 | 23767 | 10.3 |
| 24019 | <13½ | 16350 | <12½ | 24080 | 11.2 | 768 | 10.4 |
| 24023 | (13.5) | 24143 | 10.6 | | | 24441 | 10.4 |
| | | 24144 | 10.6 | X PEGASI 211614 | | | |
| RU AQUILAE 200812 | | AP CYGNI 205030b | | 16007 | <11 | RT LACERTAE 215743 | |
| 15662 | <11 | 24080 | 13.2 | 058 | (11) | 16437 | 8.2 |
| 719 | <11 | UX CYGNI 205030a | | 339 | <11 | 16460 | 8.2 |
| 987 | <11 | 16024 | <12 | 16800 | (12) | 23768 | 9.2 |
| 16323 | <11 | 042 | <12 | 23723 | 11.6 | 24441 | 8.4 |
| 23723 | 12.3 | 16350 | 12.7 | 727 | (11.5) | | |
| | | 23739 | <14 | 23762 | 10.3 | Z CASSIOPEIAE 233956 | |
| UW CYGNI 201942 | | 24080 | 11.4 | RR PEGASI 214024 | | 16438 | <13 |
| 16032 | 10.3 | UY CYGNI 205230 | | 16038 | 9.9 | 16460 | <13 |
| 038 | 10.2 | 16024 | 11.3 | 058 | 11.2 | 23797 | <13½ |
| 042 | (11) | 042 | 10.9 | 16373 | <11½ | 23803 | <13½ |
| 16052 | 10.5 | 16350 | 10.5 | 23797 | <13 | | |
| 24078 | 10.6 | | | 810 | <13 | | |
| | | | | 23813 | <13 | | |

A similar proof of identification for Series I, II, III, VI was published in our *Aggiunte* (Specola Vaticana XI pp. 147-220). In fact not a single chart of those series presents a wrong star for the variable, and similar accuracy is hoped for in the case of Series VII.

The table contains only two columns for each variable, the Julian Day and the magnitude. In the J.D. the number 2,400,000 is omitted. The hour could not be marked while the entire chart was under observation, though it was always between 8 and 12 P.M. Eastern Time. For short-period variables the identification at least is assured by the table.

The magnitudes are strictly those of the Harvard system. The Bergedorf Observatory kindly furnished standard magnitudes for each chart, which Dr. Graff had based on the Harvard scale and which Father Esch used graphically for his curves of steps.

The steps were estimated by myself but the rest of the work is all due to Father Esch at Valkenburg, Holland.

Rome, 6 March, 1927.

## REPORT ON MARS, NO. 40.

By WILLIAM H. PICKERING.

### The Position of the Planet's Polar Axis.

This matter has been dealt with previously in Reports Nos. **26**, **28**, **32**, and **33**. The first two and the last dealt exclusively with the apparitions of 1914, 1916, 1918, 1920, and 1922 by the latitude method. The third depended on position angles of the polar cap in 1924. This we believe to be a distinctly inferior method, for reasons stated elsewhere, but it was the one employed by all previous observers and was adopted by me for that reason. Nevertheless it was found that the result obtained agreed with that secured from the five previous apparitions, namely that the location of the polar axis as given in the *Ephemeris* was in error by about 3°. The suggestion was made to me by a prominent astronomer that the earlier results might be caused by a steadily increasing systematic error of my eye, causing me to place the planetary detail year by year successively farther and farther north. While this idea did not appeal to me as plausible, it had been my intention as soon as possible to continue my computations of latitude for the three remaining apparitions of 1924, 1926, and 1928, by which time the planet would again have arrived in that portion of its orbit where it was observed during the apparition of 1914, thus completing the planet's year. Should his explanation of my results be correct, we should expect to find the planetary detail perhaps become stationary, or else continue on its course towards the north. On the other hand if the position of the pole was in error, the detail would now apparently begin to shift back again towards the south. The test of the two explanations would therefore be crucial. Since it seemed to be a matter of some importance to all those interested in mapping the planet, or recording the yearly changes in position of its markings, I decided to make a determination of the apparent change in latitude throughout the planet's year of certain points at once, without waiting for the apparition of 1928, and thus securing a new and perhaps better determination of the location of the pole. As it turned out, besides recognizing a new fact, it was fortunate that I did so.

In Report No. **33**, Table I, of the 100 measured points recorded there, 30 were selected whose latitudes were supposed to be particularly well known, and these were grouped in classes A and B. In an investigation of the present character where it is important that every point should be well seen, and should not be far from the center of the disk during some drawings at least at each of the seven apparitions, it is clear that we must put a limit on their latitudes. All points were therefore re-

jected which lay outside of the torrid zone, that is to say whose latitudes exceeded 24°. Furthermore we rejected the more poorly observed of any two points which lay within 10° of longitude of one another. This was because of the fact that such points would be likely to be found on the same drawings, and would therefore give these particular drawings undue weight in our investigations. Otherwise there was no advantage to be gained by a more uniform distribution of points than that of those that remained on our list. A single stationary point accurately observed is all that is needed theoretically for this investigation.

By a third limitation we rejected all those points which were at times so inconspicuous that they could not be measured at every one of the seven apparitions. Fourthly we rejected all those points of which the average deviation of a single measure in latitude in our published list equalled or exceeded ±3°.0. This we did because we considered these points either to be slightly changeable in latitude with the seasons, or else less accurately measured. Out of the complete list of thirty latitudes determined during these five apparitions with the corrected pole, the average deviation of only one exceeded ±2°.9, while in the column determined by the *Ephemeris* there were eight. Nevertheless in the present investigation we have based our determinations exclusively upon the *Ephemeris* values. This we have done firstly in order to give the *Ephemeris* every advantage, not using any points which according to it were poorly determined, and secondly because we wished to locate the pole afresh, to start in as before from the very beginning, and as if no previous correction had been made. There now remained just ten points available for our latitude campaign.

Table I refers exclusively to the three apparitions of 1922, 1924, and 1926. Of the last two no Martian measures of latitude have previously been published. Following the plan adopted in our previous Reports the number of measures accepted for any station, at any apparition, no matter how completely observed, has been limited to four. The total number possible for any apparition for these ten stations will therefore be 40. The total number hitherto published in the *Harvard Annals* **82**, 75, for the apparition of 1922 was 20. For reasons which will appear presently this number was considered insufficient. Other measures were therefore made and combined with them, bringing the total up to 35, and these appear in Table I. The first two columns of the table give the numbers assigned to the stations in our survey, published in the *Annals* and in Reports Nos. **33** and **36**, and their longitudes as computed by the *Ephemeris*. The third column gives the corresponding mean latitudes of the five apparitions, taken from Report No. **33**, together with the average deviation of a single drawing from the mean of the five. The next three columns refer to the survey of 1922, and the remainder to those of 1924 and 1926. These columns give successively the number of measures, the mean latitude of the point with the average deviation of a single measure from that of that apparition, and the

TABLE I.

LATITUDES IN 1922, 1924, AND 1926.

| Sta. | Long. | Mean Lat. | No. | Lat. 1922 | L—M | No. | Lat. 1924 | L—M | No. | Lat. 1926 | L—M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | 19°3 | — 1°3±2°3 | 4 | + 1°6±2°0 | +2°9 | 4 | — 1°4±1°1 | —0°1 | 4 | — 1°4±1°0 | —0°1 |
| 8 | 30.4 | — 1.7±2.4 | 4 | + 2.6±1.0 | +4.3 | 4 | — 3.4±1.5 | —1.7 | 4 | — 5.8±2.4 | —4.1 |
| 23 | 72.0 | —11.6±1.3 | 2 | — 9.7±1.0 | +1.9 | 3 | —10.5±1.6 | +1.1 | 2 | — 8.2±1.6 | +3.4 |
| 24 | 84.1 | —22.0±1.6 | 4 | —20.9±2.9 | +1.1 | 4 | —22.5±0.8 | —0.5 | (4 | —17.4±0.8 | +4.6) |
| 43 | 165.1 | —18.4±2.9 | 4 | —14.1±1.2 | +4.3 | 4 | —14.1±1.5 | +4.3 | 4 | —21.6±1.4 | —3.2 |
| 46 | 175.5 | + 0.5±2.0 | 1 | + 3.8 | +3.3 | 3 | — 2.5±0.8 | —3.0 | 2 | — 0.6±1.4 | —1.1 |
| 50 | 196.5 | —14.5±2.8 | 4 | — 9.4±2.8 | +5.1 | 4 | —12.3±1.7 | +2.3 | 4 | —16.7±2.6 | —2.2 |
| 58 | 231.9 | — 2.2±1.8 | 4 | + 0.3±0.8 | +2.5 | 4 | + 0.8±1.0 | +3.0 | (4 | —11.7±0.6 | —9.5) |
| 94 | 346.3 | — 2.6±2.7 | 4 | — 0.5±1.4 | +2.1 | 4 | — 2.8±0.8 | —0.2 | 4 | — 1.4±0.7 | +2.0 |
| 98 | 359.0 | + 8.6±1.9 | 4 | +11.0±2.8 | +2.4 | 4 | + 5.5±1.6 | —3.1 | 4 | + 0.1±2.0 | —5.0 |
| Mean | | ±2.2 | | ±1.8 | +3.0 | | ±1.2 | +0.2 | | ±2.0 | —1.3 |

TABLE II.

LATITUDES ACCORDING TO THE EPHEMERIS.

| Sta. | 1914 ⊙ L—M | 1916 ⊙ L—M | 1918 ⊙ L—M | 1920 ⊙ L—M | 1922 ⊙ L—M | 1924 ⊙ L—M | 1926 ⊙ L—M |
|---|---|---|---|---|---|---|---|
| 7 | 8°6—0°7 | 53°0—0°9 | 89°4—0°8 | 130°1—0°5 | 181°4+2°9 | 246°7—0°1 | 300°4—0°1 |
| 8 | 6.4—2.0 | 55.8—1.5 | 83.1 0.0 | 122.2—0.7 | 192.8+4.3 | 244.2—1.7 | 305.1—4.1 |
| 23 | 14.7—3.2 | 58.8+1.5 | 86.0+0.1 | 130.2+0.5 | 182.6+0.9 | 257.9+1.1 | 326.0+3.4 |
| 24 | 14.2—0.9 | 58.8—2.2 | 86.0+0.4 | 111.7—0.9 | 181.5+3.4 | 237.0—0.5 | (309.8+4.6) |
| 43 | 17.5—1.4 | 50.6—3.1 | 87.2—0.2 | 143.6—0.1 | 170.1+4.5 | 241.7+4.3 | 310.9—3.2 |
| 46 | 10.9+1.8 | 53.6—1.2 | 97.1—3.6 | 143.6—0.2 | 197.8+3.3 | 234.3—3.0 | 316.4—1.1 |
| 50 | 24.1—5.0 | 70.2—2.0 | 95.7+0.7 | 122.9+5.1 | 173.5+1.4 | 244.7+2.3 | 300.2—2.2 |
| 58 | 14.6+0.5 | 44.2—0.8 | 88.2—0.6 | 132.5—1.2 | 183.9+1.9 | 243.6+3.0 | (308.1—9.5) |
| 94 | 17.7—2.6 | 47.7+0.5 | 90.2—0.1 | 129.8+0.5 | 168.6+1.9 | 247.3—0.2 | 311.9+2.0 |
| 98 | 4.7—3.1 | 63.2+0.9 | 89.5—1.7 | 174.0+1.5 | 167.0+2.5 | 246.7—3.1 | 320.8—5.0 |
| Mean | 13.3—1.7 | 55.6—0.9 | 89.2—0.6 | 134.1+0.4 | 179.9+2.7 | 244.4+0.2 | 311.5—1.3 |

difference between this mean latitude and the mean latitude of the first five surveys as given in the third column of the table, which we have taken as a standard.

It is believed that these ten points are the most reliable ones so far found, for latitude determinations to be carried out through the planet's entire year, taking into consideration their latitude, their visibility, and their stationary character. Faint prolongations, sometimes double, of both Titanum and Laestrigonum were detected in 1924, but they were not sufficiently dense to interfere with the measures. The names of the ten stations are as follows: 7 Thymiamata f., 8 Aromatum S. p., 23 Maeisia, 24 Solis N., 43 Titanum N., 46 Aesculapius, 50 Laestrigonum N., 58 Cimmerium N., 94 Edom S., and 98 Furca N. f. The total number of measures included at each of the apparitions is as follows: 1914 20, 1916 20, 1918 20, 1920 18, 1922 35, 1924 38, 1926 36. Total 187.

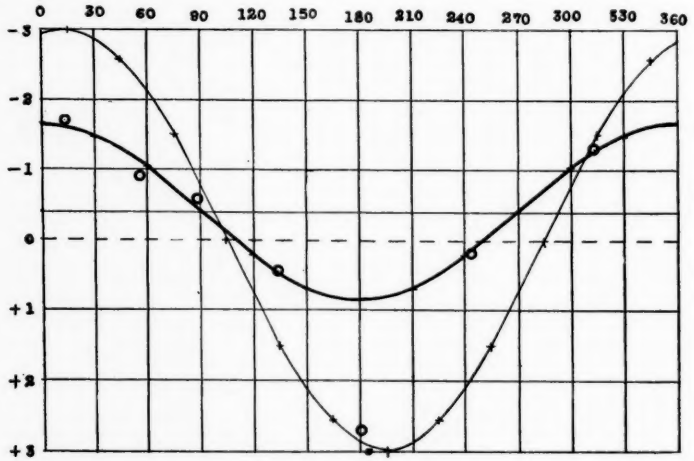



FIGURE 1.

In Table II, following the numbers of the stations, we have fourteen columns which give ⊙ the mean solar longitude of the planet at the time that the observations of each station were made at each apparition, and the difference between the latitude at that apparition and that of the mean of the first five apparitions. The numbers in the first eleven columns are deduced from the detailed account given in the *Harvard Annals*. The numbers in the last four, excepting the solar longitudes are copied from the equivalent columns of Table I. The means of the last fourteen columns are plotted as circles in Figure 1, with the solar longitudes indicating the position of the planet in its orbit as abscissas, and the values of L—M as ordinates. For reasons

which will presently be explained the measures of Stations 24 and 58 made in 1926 were rejected. If the pole were correctly located according to the *Ephemeris,* if the stations were stationary, and the observations without error, it is clear that the result would be a straight horizontal line with ordinate 0°. If the revised position of the pole, published in Report No. **33**, were correct, the observations should lie along the finer curve of sines. In point of fact they agree better with the heavier line. The two curves are obviously similar but the latter has less than one half the amplitude of the former.

Disregarding for the moment the last two circles in the figure, and considering only the first five, based on the five apparitions from which the finer curve was deduced, we see at once that it only agrees fairly well with two of them. This curve was computed from observations of twenty-six accurately observed stations, all of which were believed to be fairly stationary upon the planet. The little circles in the figure were based only on the ten stations within the planet's torrid zone, which gave the least evidence, according to the survey based on the *Ephemeris,* of individual motion. It is true that none of the circles differ from the curve by as much as 1°.5 or 60 miles, and at the distance at which the planet was usually observed during these apparitions, with a diameter let us say of 14″, this deviation amounts to only about 0″.2, but we expect much better agreement than that. Disregarding now the observations made in 1922, and turning to the heavier curve, we find that the six remaining observations agree with it in a more than satisfactory manner, their average deviation amounting to only ±0°.09, or to ±3.3 miles. For the last two apparitions, with an average diameter of 20″, this would amount to only ±0″.016. But this is too close, and must be accidental. Nevertheless with an average deviation of a single observation of ±1°.5, as we see by Table I was obtained in 1922 and 1924, when we were using the Harvard telescope, we should expect for the mean of let us say 25 observations a deviation of ±0°.3. This would correspond to ±11.0 miles on Mars, and when the diameter of the planet was 20″, to an average deviation of ±0″.052, or to a probable error for the mean of each apparition of ±0″.043. This is the justification for rejecting the drawings of the apparition of 1922.

Now then the question immediately arises what is the matter with these drawings?

The first step taken was to make all available measurements of them up to the adopted limit of four to each station. This gave us, as we have seen by Table I, 35 measures instead of 20. The result when plotted is a black dot in solar longitude 185°. Instead of helping the agreement with the heavy curve it makes it worse, although bettering it slightly with the other. Turning to the latitude columns of Table I, we find that the average deviation for 1922 stands between those of 1924 and 1926, which agree well with the heavy curve. The latitudes of the ten points in 1922 therefore all hang together as closely as in the

two later years.

There seem to be three available explanations of the difficulty. (a) That the lighter curve is the correct one, and that the errors are accidental. (b) That the heavier curve is the correct one, and that my eye without changing its accidental errors appreciably, changed its systematic one, so that during that apparition, and during that one only, I drew all the stations on the average 2° too far to the north. Since during this apparition the equator passed near the center of the disk, and all the stations therefore passed near its center, there seems to be no obvious reason why such a systematic error should have arisen. (c) It is suggested that about half-way between the summer solstice of the northern hemisphere and its autumnal equinox, when the moisture from the melted northern cap had passed well to the south, vegetation began to develop on the deserts on the borders of the maria, carrying them in the course of three terrestrial months to an average distance of 80 miles farther north than they had been before. It is further suggested that those portions of the deserts, lying on the borders of the maria, are more suitable for vegetation than those desert regions farther to the north, where the elevation is perhaps greater, and the temperature lower. Three terrestrial months later, when the water supply had reached its minimum, being largely locked up in the southern polar cap and the surrounding maria, vegetation had again retreated to its former more permanent location. At the opposite season of the Martian year, when the southern cap had melted, the moisture never reached the deserts, but was all absorbed by the maria themselves. Thus during about one-quarter of the Martian year our method of locating the planet's axis by means of a survey of its surface is not available.

In Report No. **26** we suggested that the large difference between the latitudes for 1914 and 1922, amounting to 2°.9, might be accounted for either by an error in the location of the pole, or by a universal advance of vegetation in the interval towards the north. We rejected this last explanation as improbable. It now appears that both explanations are correct, and combine to produce the actual result, the vegetational advance being slightly the more important of the two. An examination of Table I, under the column L—M for 1922, shows that while three of the stations, numbers 8, 43, and 50, are especially effective in carrying the average of that year to the north, yet there is not a single station which does not lie below the heavy curve. The effect therefore appears to be universal.

As bearing on this question of a shifting of the markings with the seasons, if we turn again to Report No. **33**, Table I, we shall find, as previously mentioned, that 8 stations out of the 30 were ruled out because their average deviations in latitude equalled or exceeded ±3°.0. At first we might assume that these large deviations were due to these stations being badly observed. Let us turn now however to Table II in

the same Report. In its eighth column are given the differences in latitude of 27 of these stations as observed at the apparitions of 1914 and 1922. Their mean difference —5°.64 was used later in that Report to compute the lighter of the two sinusoid curves shown in Figure 1. Turing now to the eight stations themselves, we find that six of them, namely numbers 68, 63, 55, 17, 69, and 92, show higher differences in Table II than any other of the 27 stations, the lowest being —7°.4. The difference of the seventh of these stations, number 74, is exceeded by only that of one station. The difference of the eighth station, number 54, stands about midway in the list.

Now all this evidently means not that these eight stations were badly drawn, as we at first assumed, for in that case the measures would have been widely scattered, but would not necessarily give sinusoids of large amplitude. It was because they had such large amplitudes, much larger than the other stations, as indicated by their large differences in Table II, that their average deviations from their mean positions in Table I were so large. They were well observed, but moved more than the others between the apparitions of 1914 and 1922. Indeed the average motion of these seven stations extended from an ordinate of —3°.8 in 1914 to one of +4°.9 in 1922, a difference of 8°.7. The average difference of the 10 selected stations was only 4°.8. It is obvious that such a range of difference must be caused by something other than an error in the location of the planet's axis, namely an actual seasonal shifting of some of the stations over the surface of the planet. We thus find that many, probably all, of the stations do actually move at certain seasons of the year. I therefore conclude, in spite of the fact that the curve with the larger amplitude agrees better with the varying positions of all the 26 stations, that this fact is due largely to their irregular proper motions over the surface of the planet, and that the curve of lesser amplitude, based on stations which are generally stationary is the curve representing the real error in the position of the axis of the planet, and is therefore the curve that we should adopt. For six apparitions out of the seven the ordinates agree well with this curve, and I believe that the mean position of the stations in the seventh, in 1922, should be rejected for the purpose now in hand.

We must now explain in some detail why the drawings of Station 24 during the apparition of 1926 were rejected. Those who read our last previous Report will recall that during that apparition the whole face of Thaumasia was transformed. This fact was noted and commented upon by several of our observers. Figure 17 shows well the temporary meridional extension of Solis, while Figure 20, which may be compared with Figure 19, shows that the change was due to an extension north and south, rather than a contraction east and west. Central Solis lies outside the torrid zone, and its location during the southern winter is sometimes uncertain. The latitude of the southern side of the formation was measured on the four drawings from which the measures of

the northern side were made. Its mean latitude proved to be 30°.5 S, which is identical with its position on our map, published in Report No. **36**. It therefore appears that the extension of this formation was toward the north in 1926, and the results for 1926 in Table I verify this statement, and indicate why it was proper to omit it.

The case of Station 58 is similar. It lies on the edge of a region noted for its changes, and which exhibited very marked alterations at the apparition of 1926. We shall hope to discuss these in a later Report. We were not at all surprised therefore on constructing Table II to find the exceptionally large deviation of 9°.5 in the last column, and we attribute it to actual motion of this Station, and feel justified therefore in omitting it. Since by the smooth character of our curve shown in Figure 1 we think we have now eliminated all effects due to advancing vegetation, we believe we may safely take the semi-amplitude of the curve 1° 15′ as the real error in position of the pole as given in the *Ephemeris*. Since the node of our curve lies in solar longitude 90°, our result for the inclination of the axis of the planet to the axis of its orbit coincides closely with the value found in the *Ephemeris*, and is **24° 1′**. A distinct advantage of this graphical treatment of the measurements over the analytical method previously adopted is that the position of the pole now depends on all the measurements made at six different apparitions extending throughout the planet's year, instead of depending only on the three apparitions of 1914, 1918, and 1922. Indeed it was largely the results obtained in 1920 and 1924 which led me to the conclusion that those secured in 1922 should not be considered as decisive.

The fact that the horizontal axis of the curve lies 0°.40 above the origin produces no effect on the position of the axis of the planet, but merely indicates that our previous assumption as to the location of the zero ordinate, namely as to the planet's equator, was in error by about 15 miles. The location of the pole now becomes **316° 7′** in right ascension, or **21$^h$ 4$^m$ 27$^s$**, and **+53° 38′.5** in declination, the epoch being 1905. The change from the *Ephemeris* values is 1°.4 in right ascension and 0°.9 in declination, the total change amounting to 1°.25 measured on a great circle. The Adopted constants C and D of our former computations now become +1°.25 and 0°. In order to correct the *Ephemeris* computations of any observations for this Adopted position of the pole, we may use the heavy curve of Figure 1 directly to correct the latitudes, substituting A for ⊙ as described in Report No. **28**, but for the longitudes we must compute the curves by means of the new constants C and D. However, for all practical purposes the error will be very small if we take two-fifths the correction as given by the curves published in that Report, or in the *Harvard Annals* **82**, 75, and add the result to the *Ephemeris* position.

While it is believed that the above constants give all the accuracy that is at present required by our observations of the planet, and will readily

indicate all the more important seasonal shiftings of the canals and maria, yet should anyone care to improve on them the following suggestions may perhaps be of value. In Report No. **33** we showed that to obtain the same accuracy by drawings that we can secure with the micrometer would require 1.3 times as long. A revision of this result raises the figure to 1.6. A micrometer should therefore be used, which will also insure more satisfactorily against personal error. The observations should be continued through thirteen years. Two of our stations, Solis N. and Edom S., have no definite longitudes, yet gave very satisfactory results. It is quite possible that the three bays, Titanum N., Laestrigonum N., and Cimmerium N., may have small proper motions, and that better results could be obtained by measuring the extreme southern extent of the promontories preceding them. The experiment might be worth trying. Furca N. p. is often better defined than Furca N. f., although this was not the case in 1926. Aesculapius and Maeisia are often inconspicuous, as is shown by Table I. Aurorae, Elysium, Libya, Nepenthes, and Hammonis should be avoided, because of large proper motions.

Private Observatory, Mandeville, Jamaica, B. W. I.
April 23, 1927.

## J. L. E. DREYER.*

It was learned with sorrow by the English members of the Astronomische Gesellschaft Congress at Copenhagen in August of this year (1926) that Professor Dreyer was at the time very ill. By his death on September 14, 1926, Urania lost one of her diligent, faithful, and eminently successful worshippers whose name was known and esteemed by all students of astronomy.

Dreyer was born in Copenhagen on February 13, 1852. Belonging to a highly cultured family of officials—his father having the rank of lieutenant-general when he died in 1898—he had, even in his youth, a number of diverse interests, not only scientific, but also linguistic and historical. He matriculated at the university in 1869, and one may well suppose that it was the influence of d'Arrest, at that time professor of astronomy and director of the newly erected observatory at Copenhagen, which made astronomy the beneficiary of Dreyer's energy and work. He took his professional examination in astronomy (masters' parley) in 1874, and was soon after appointed assistant to Lord Rosse at the latter's observatory, Birr Castle in Ireland. He was, therefore, only 22 years old when he left his native land. He lived in Great Britain

*A paper by Carl Burrau, published in *Populär Astronomisck Tidskrift*, Parts 3 and 4, 1926; translated for POPULAR ASTRONOMY by Phelva Jerlow, St. Olaf College.

for 32 years, but kept up constantly his connection with Denmark, which he often visited.

As stated he spent his astronomical apprenticeship at the Observatory in Copenhagen. This Observatory was built in 1859-61 in accordance with d'Arrest's plans, and its largest instrument—at that time called the "great" refractor of Copenhagen, but later, when surpassed by so many others, more modestly termed the "10½-inch refractor"—was specially constructed with a view to the study of nebulae. It was quite natural that Dreyer should here be inspired with a liking for nebular astronomy, and that d'Arrest should be peculiarly able to teach him the necessary technique of observation. One may also suppose that it was Lord Rosse's plentiful supply of instruments, specially constructed for the study of nebulae, which lured Dreyer to Birr Castle. Already in 1878 he made known the results of his own observations in "A Supplement to Sir John Herschel's General Catalogue of Nebulae and Clusters of Stars." At that time he published also the record of observations of nebulae previously made with the famous reflecting telescope in Birr Castle. In 1878 Dreyer was called to Dublin as observer; in 1882 he honored his native land and her university by defending before the faculty in Copenhagen his doctor's thesis on the determination of the precession constant. The same year he was appointed director of the Armagh Observatory, which position he held until 1916.

The astronomy of the nebulae constantly took most of his time and efforts and in this field is to be found his greatest scientific contribution: "New General Catalogue of Nebulae and Clusters of Stars," published in 1888, and its two supplements, published in 1895 and 1908, are indeed among the necessary and much used reference works of every observatory.

He also busied himself with other branches of astronomy, particularly with star catalogues, and published "Second Armagh Catalogue of 3500 Stars," and "Mean Places of Red Stars." The latter shows that he already in 1882 realized that the red stars deserve special attention.

It was quite natural that a man with such comprehensive knowledge should be tempted to make a trial as publisher of a periodical. And he was, indeed, assistant editor of "Copernicus, an International Journal of Astronomy," during its entire existence.

In yet another field did Dreyer accomplish something beyond the ordinary, namely in the field of history. We refer not so much to his editing of the works of W. Herschel as to his services in bringing about an appreciation of Denmark's greatest astronomer, Tycho Brahe. His biography of Brahe with the sub-heading "A Picture of Scientific Life and Work in the Sixteenth Century" could only be written by an astronomer of Dreyer's widely inclusive knowledge of history and language, and the publication of Tycho's collected works—some of which had never been previously published—could hardly have been done by anyone else.

From 1916 until his death Dreyer lived at Oxford as a pensioner. His new home-land esteemed him according to his merit; in 1916 he received the Gold Medal of the Royal Astronomical Society and for the period 1923-1925 he was president of this respected society.

## A NEW LAW OF PLANETARY DISTANCES AND ORBITAL VELOCITIES.

By HSIN P. SOH.

About 1772 Bode announced a law which gives approximately the distances from the sun of all the planets then known. This law seems to be merely a curious coincidence, having no natural basis or physical foundation. Briefly stated it is as follows: "Write a series of 4's; under each one after the first write a series as follows: 3, 6, 12, 24, 48, etc.; the sums, when divided by 10, will give approximately the relative distances of the successive planets in terms of the distance of the earth as the astronomical unit." The algebraic expression is $4 + 3 \times 2^{n-2}$. This expression, however, does not give the first term of the series, which is 4 instead of 5½ as it would be from the formula for $n = 1$. The law, while fairly accurate for the planets known at that time, and although it helped to suspect the existence and distance of Neptune, and suggested a missing planet between Mars and Jupiter which later led to the discovery of the asteroids, yet failed to give the distance of Neptune with even approximate exactness, differing by about 29%. It has long been recognized that a more satisfactory empirical law is desirable. Attempts have been made to devise such a law but without satisfactory results.

In thinking about this matter, I have devised a law which seems to be more general in its application and to have, perhaps, a real physical significance. It may be stated as follows: "The radii of orbits of any natural bodies moving around a central mass are proportional to the squares of the integral numbers 1, 2, 3, 4, etc., except for the effects of the mutual attractions of the bodies themselves." Stated in this general way, the law, if it has real physical significance, should apply to the planets of the solar system, to the satellites of any planet, and to the orbits of electrons in the atom. The deviation of any particular body should be accurately accounted for by the attractions of its neighbors.

The law may be stated algebraically as follows: $R = Kn^2$, where $R$ is the radius of the orbit, $n$ is an integer and $K$ is a constant for any one system of bodies, its value probably depending on the mass of the central body of the system. When $K$ has once been determined for any system, the distances of all bodies in that system follow at once from their ordinal numbers. However, it is not necessary to assume that all possible orbits are actually occupied. Thus, in the solar system, if $K$

is taken as 4,000,000 miles and Mercury is given the number 3, Venus No. 4, Earth No. 5, Mars No. 6, Jupiter No. 11, Saturn No. 15, Uranus No. 21 and Neptune No. 26, the distances may be calculated with an accuracy considerably greater than that given by Bode's law. The missing numbers may correspond to the orbits of small undiscovered planets or to unoccupied orbits. The accompanying tabulation shows how the new law compares with the actual distances of the planets and with Bode's law. It is noticed that the percent of error, in most cases, is less than that of Bodé's law and that the new law does not break down in the case of Neptune, as Bode's law does.

COMPARISON OF PLANETARY DISTANCES COMPUTED BY THE LAW $R = Kn^2$, WITH THE OBSERVED DISTANCES AND WITH THOSE GIVEN BY BODE'S LAW.

(All distances in millions of miles. $K = 4{,}000{,}000$ miles.)

| n | Planet | Observed Mean Distance | Bode's Law | Diff. % | $Kn^2$ | Diff. % |
|---|---|---|---|---|---|---|
| 1 | ..... | ..... | ..... | .... | 4 | .... |
| 2 | ..... | ..... | ..... | .... | 16 | .... |
| 3 | Mercury | 36.0 | 37.2 | 3.3 | 36 | 0.0 |
| 4 | Venus | 67.2 | 65.0 | 3.2 | 64 | 4.8 |
| 5 | Earth | 92.9 | ..... | .... | 100 | 7.6 |
| 6 | Mars | 141.5 | 148.6 | 5.0 | 144 | 1.8 |
| 7 | ? | ..... | ..... | .... | 196 | .... |
| 8 | Ceres | 257.1 | 260.3 | 1.2 | 256 | 0.3 |
| 9 | ? | ..... | ..... | .... | 324 | .... |
| 10 | Thule | 400 | ..... | .... | 400 | 0.0 |
| 11 | Jupiter | 483.3 | 483.1 | 0.04 | 484 | 0.14 |
| 15 | Saturn | 886.1 | 929.0 | 4.8 | 900 | 1.8 |
| 21 | Uranus | 1781.9 | 1820.8 | 2.2 | 1764 | 1.0 |
| 26 | Neptune | 2791.6 | 3606.7 | 29.0 | 2704 | 3.1 |
| 31 | ..... | ..... | ..... | .... | 3844 | .... |
| | Average difference, % | | | 5.4 | | 2.05 |
| | Average difference, excluding Neptune, % | | | 2.8 | | |

The largest percent of difference occurs in the cases of Venus and the Earth, the distance of the former being about 3.2 million miles greater and that of the latter about 7 million miles less than the distances suggested by the law. Jupiter, on account of its great mass and the rather large distances separating it from the other planets, would be only slightly perturbed and should conform quite closely to the law. This, we see, it does, the difference being only 0.14 of one percent. The fact that Uranus and Neptune are both somewhat farther out than the law may require suggests the existence of a still more distant planet,*

*There are two possible orbits outside that of Neptune, one of which (most likely No. 31) must be occupied by a real planet, possibly both of them. They would be suggested as follows:

No. 31. Distance about 3844 million miles.
Velocity about 2.9 miles per sec.
Diameter about 5 times that of the earth.
Density about two (?) times that of water.
Eccentricity about .08 or .09.

No. 36. Distance about 5184 million miles.
Velocity about 2.5 miles per second.
Diameter about 6.8 times that of earth.
Density about 2.4 times that of water.
Eccentricity about .21.

probably of enormous mass. If we assign to this planet the ordinal number 31 in the system, its distance would be 3844 million miles. Astronomers have searched for such a planet, but it has never been discovered.

Since the distances of the planets are connected with their periods by Kepler's Law which states that the squares of the periods are proportional to the cubes of the mean distances, it should be possible to compute the period and therefore the orbital velocity of any planet from its order number in the system. The formula would be $V = U/n$. Thus, if the unit velocity be taken as $U = 90$ miles per second, the orbital velocity of any planet would be 90 mi. per sec. divided by its order number. The following table shows how well the velocities computed in this way agree with the observed velocities.

| | No. 1 | No. 2 | No. 3 Merc. | No. 4 Venus | No. 5 Earth | No. 6 Mars | No. 11 Jupiter | No. 15 Saturn | No. 21 Uranus | No. 26 Neptune |
|---|---|---|---|---|---|---|---|---|---|---|
| Ob.Vel. | .. | .. | 30.0 | 21.9 | 18.5 | 15.0 | 8.1 | 6.0 | 4.2 | 3.4 |
| $90/n$ | 90 | 45 | 30.0 | 22.5 | 18.0 | 15.0 | 8.18 | 6.0 | 4.29 | 3.4 |

This remarkable agreement seems to indicate that the law has a real physical significance. Bode's law can not give any information as to orbital velocities.

I have endeavored to apply this law to the satellites of Jupiter, Saturn, and Uranus, and apparently it applies with some degree of success although on account of the small distances separating the satellites from each other they would naturally produce large perturbations of each other's orbits, and the law could not be expected to agree with the observed distances with the same degree of accuracy with which it applies to the planets themselves.

The radii of the stable orbits of the electron in the Bohr model of the hydrogen atom follow this law exactly, as there are in this case no perturbations due to other electrons.

I hope, in a later paper, to give more of the details and tests of my theory, as well as methods of calculating the value of $K$ for any system.

Baker University, Baldwin City, Kansas.

## OCCULTATION OF SATURN BY THE MOON, 1927 JULY 10.

By REV. EDWARD C. PHILLIPS, S.J., and JOHN A. RLATCHFORD, S.J.

The occultation of Saturn which takes place on July 10 occurs under rather unfavorable conditions. An inspection of the accompanying maps, which were constructed according to the method made so familiar to us by Father Rigge's many contributions to POPULAR ASTRONOMY, shows that the immersion will be visible only in the eastern quarter of the United States whilst the emersion will be visible throughout the

eastern half of the country. However, as the time of immersion varies from 4:30 P.M. (Eastern Standard Time) for the southeastern states to about 5:20 P.M. for the northeastern states, and as the time of sunset for the entire region varies from about 7:00 P.M. (Local Mean Time) to 7:45 P.M., the immersion will take place from two to three hours before sunset. Moreover for most of this region it will occur at or shortly after moonrise, and hence quite close to the horizon. This,

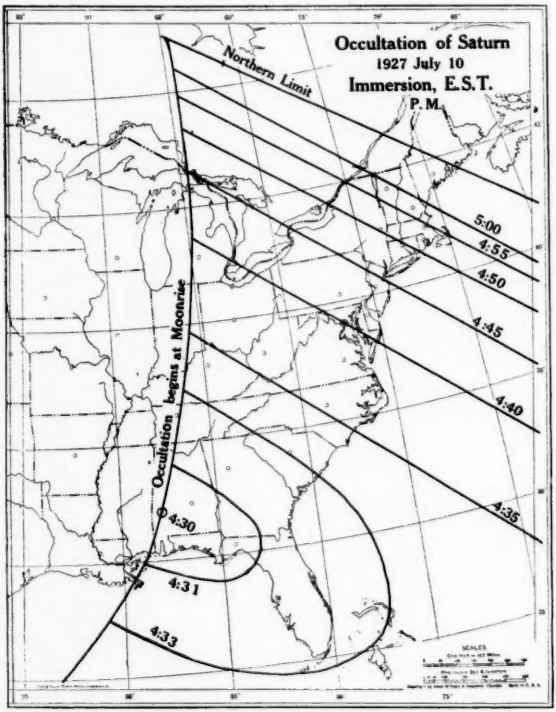



FIGURE 1.

of course, will make the observations difficult and it also makes the application of the graphical method of prediction somewhat less accurate than usual, but the accompanying maps are probably correct to within about two minutes in time and one degree in position as far as the location of the time curves is concerned. The position angles for emergence are not quite so certain, though the prediction for Washington as read from the map agrees to within one degree with that given in the *Ephemeris*.

The little circle on the moonrise line of the immersion chart at the point marked 4:30 indicates the time and place at which the immersion

is first visible; this place is about one hundred miles north of Mobile and is, of course, the point at which the disk of the moon as seen from Saturn would first come in contact with the disk of the earth. The earliest moment at which the emersion is visible in the United States is about 5:23 P.M., in the southern part of Texas.

The emersion, though it occurs in general about an hour later than the immersion, still occurs in daylight from an hour and a half to three hours before sunset, and as it takes place on the bright limb of the

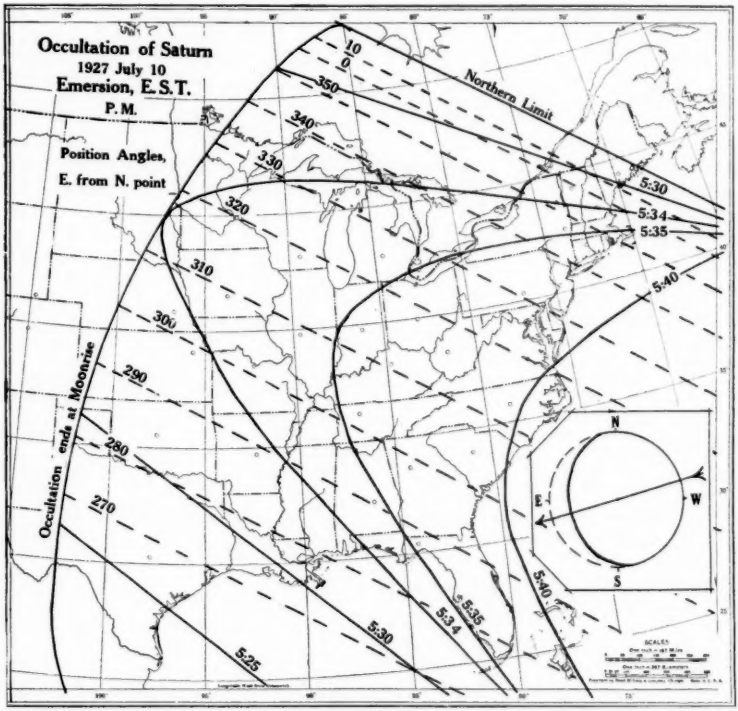



FIGURE 2.

moon, the observations will be even more difficult than for immersion, but they are not hopeless. The computations and the charts are made for the *center* of the disk of Saturn; no computations have been made for the rings, but according to the observations of Mr. Hamilton published in the May number of POPULAR ASTRONOMY (page 300) the outer ring comes in contact about two and a half minutes before the center of the disk, and this gradual progress of the occultation will be of very considerable help in enabling the observer to locate the emerging planet before the disk appears.

It should be noted that the time used in these charts is Eastern Standard Time, a change from Central Time used heretofore.

Georgetown College Observatory, Washington, D. C.
and Woodstock College, Woodstock, Md.

## THE EARTH AS SEEN FROM THE SUN.

By FREDERIC R. HONEY.

The great variations in the form and position of the shadow cast upon the earth by the moon during a total eclipse of the sun are due to the inclination of the earth's axis combined with the annual changes in the relative positions of the sun and earth, exposing to the shadow areas differing greatly in latitude and longitude.

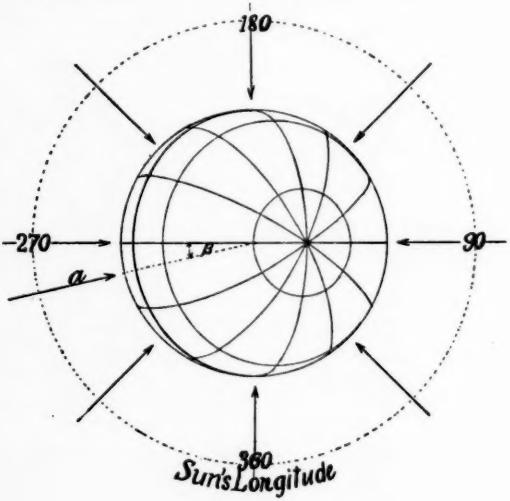



FIGURE 1.

PROJECTION OF THE EARTH ON THE PLANE OF THE ECLIPTIC.

If the earth, as seen at the distance of the sun, be very highly magnified, it would be represented by a perspective drawing which would not differ practically from a projection on a plane perpendicular to the radius vector.

Fig. 1. During the earth's annual revolution an observer at the sun would see the earth in the directions indicated by the arrows whose positions are given by the sun's longitude; and Fig. 2 represents the earth

at the dates of the solstices, the equinoxes, and intermediate positions. Beginning with the projection when the earth's heliocentric longitude is $0°$, and the sun's longitude is $180°$, the inclination of the axis to the plane of the ecliptic is shown in its true value; and the equator and parallels are projected in straight lines. From this projection that of longitude $90°$ is determined; and those of $45°$ and $135°$ are simple exercises in spherical projections. Fig. 2 inverted shows the projections for the second half of the revolution.

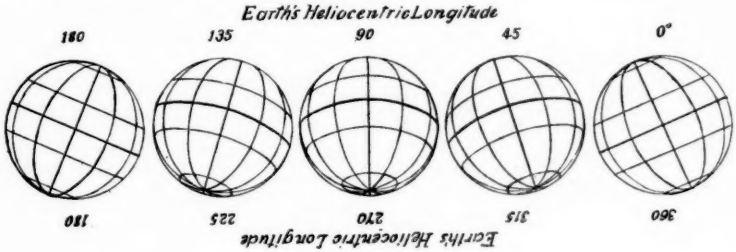



FIGURE 2.

This year provides examples of central eclipses, which, separated by an interval of nearly six months, illustrate the great variations in the position of the path of the eclipse.

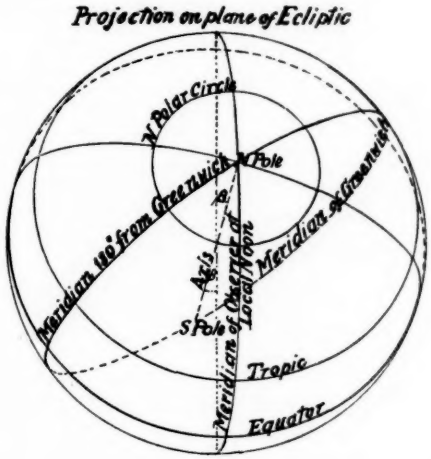



FIGURE 3.

Fig. 3 and 4. The annular eclipse of Jan. $3^d\ 20^h\ 22^m.7$. The sun's longitude is $282°\ 28'$. The direction in which the earth is seen is indicated by the arrow $a$ in Fig. 1. The angle $\beta = 12°\ 28'$ ($282°\ 28'$ —

270°). The projection of the earth's axis in Fig. 3 is inclined at this angle. This figure includes the equator, tropic, polar circle, the meridian of Greenwich, that of 180° from Greenwich, and the meridian of the observer at local noon. The longitude of the latter is 124° 34′. The meridians in Fig. 4 are plotted at intervals of 20°; and the parallels of −30°, −40°, −50°, and those of the observer at sunrise, at sunset, and at local noon. While the drawing is unavoidably very small, the points where the path of the annulus crosses the parallels and meridians may be compared with the corresponding points in the plot of the *Nautical Almanac*.

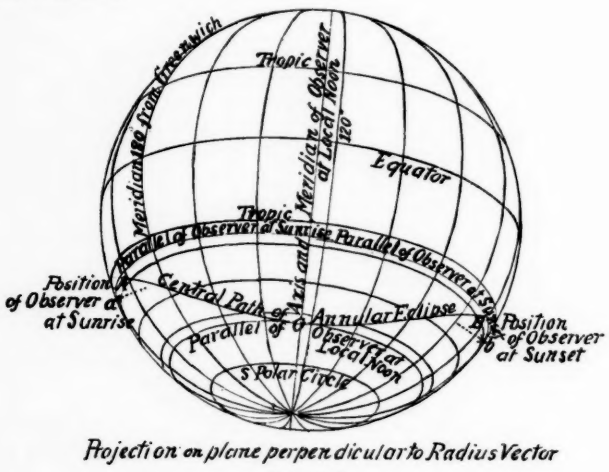



FIGURE 4.

The first half of the path of the eclipse $AO$ is shown at the "date," *i.e.* when the observer is at $O$ at local noon. The observer, whose position at sunrise is at $a$, moves to $A$. During the second half $OB$, the observer at sunset moves from $B$ to $b$, *i.e.* to the observer's position at sunset.

If the drawing be made on a large scale the points $a$ and $b$ may be clearly defined. They are the points where the parallels are tangent to the great circle.

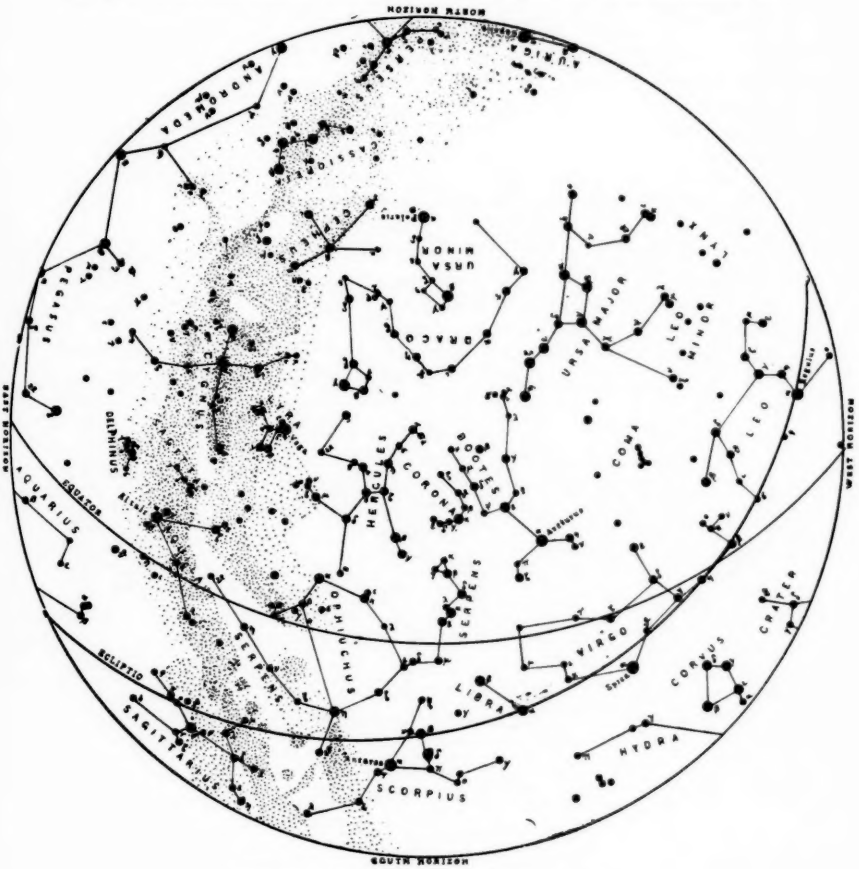
In order to avoid confusion in a drawing of these dimensions the constructions are omitted. The student would determine them by means of the projections of the parallels in Fig. 3 which would be intersected at the required points by a diameter parallel to the plane of projection. This diameter is the projection of the great circle in Fig. 4.

Trinity College, Hartford, Connecticut.

## PLANET NOTES FOR JULY AND AUGUST.

By CLIFFORD E. SMITH.

The *Sun* at the beginning of July will be moving southeast in the central part of the constellation Gemini. During these two months it will cross the eastern part of Gemini, cross Cancer, and at the end of August will be in the central part




THE CONSTELLATIONS AT 9:00 P.M. JULY 1.

of Leo. On August 23 it will be about two degrees south of the bright star Regulus (α Leonis). The position of the sun for July 1, August 1, and August 31 will be respectively:

R.A. $6^h\ 36^m$, Decl. $+23°\ 12'$; R.A. $8^h\ 41^m$, Decl. $+18°\ 20'$; R.A. $10^h\ 33^m$, Decl. $+9°\ 6'$.

The phases of the *Moon* will occur as follows:

| | | | | | |
|---|---|---|---|---|---|
| First Quarter | July | 6 | at 7 | P.M. | C.S.T. |
| Full Moon | | 14 | " 1 | P.M. | " |
| Last Quarter | | 21 | " 9 | A.M. | " |
| New Moon | | 28 | " 12 | M. | " |
| First Quarter | Aug. | 5 | " 12 | M. | " |
| Full Moon | | 12 | " 11 | P.M. | " |
| Last Quarter | | 19 | " 2 | P.M. | " |
| New Moon | | 27 | " 1 | A.M. | " |

The moon will be at apogee (farthest from the earth) on July 7, August 4, and August 31, and at perigee (nearest the earth) on July 19 and August 16.

*Mercury* will be on the eastern border of Gemini on July 1, and it will set about an hour and a half after the sun. Its apparent motion among the stars during July will be about eleven degrees westward. In August it will be moving eastward again. At the end of August Mercury will be near Regulus ($\alpha$ Leonis) in Leo. On July 20 it will be at inferior conjunction; on August 8 it will be at greatest elongation west when it will rise about an hour and twenty minutes before the sun. Mercury will be in conjunction with Neptune on August 27. At that time the two planets will be about a degree apart.

*Venus* will be in Leo during these months. On July 6, it will be about a degree from Regulus. It will be at greatest elongation east on July 2, and it will reach its maximum brilliancy on August 5. On July 2 Venus will be in conjunction with Neptune, being separated by only 49 minutes of arc; on August 27 Venus will be in conjunction with Mars when Mars will be about 9 degrees north of Venus. Early in July Venus will set about three hours after the sun. Late in August it will set about an hour after sunset. It will therefore be a brilliant object in the evening sky during this period.

*Mars* will be in Cancer early in July. During these months it will cross into Leo and it will be found near the border of Virgo late in August. Mars will be in the western sky at sunset. On August 1 it will set about an hour and fifteen minutes after the sun. Mars will be in conjunction with Neptune on July 17 (apparent separation 43 minutes of arc).

*Jupiter* will be in Pisces during this period, and it will be visible after midnight.

*Saturn* will be in Scorpio. On August 25 it will be in quadrature east of the sun. It will therefore be on the meridian at sunset on that date. Saturn will be in conjunction with Uranus twice during these months. The first time on July 9 (apparent separation 38 minutes of arc) and again on August 19 (apparent separation 50 minutes of arc).

*Uranus* will be in Pisces near Saturn. As has been mentioned, Uranus will be in conjunction with Saturn once in July and once in August.

*Neptune* will be in Leo. On August 20 it will be in conjunction with the sun. It will therefore be too near the sun for observations during these months. Neptune will be in conjunction with Mars as has been mentioned in the notes on Mars.

## Occultations Visible at Washington.

[From the *American Ephemeris.*]

| Date 1927 | | Star's Name | Magnitude | IMMERSION. Washington C.T. | Angle from N | EMERSION. Washington C.T. | Angle from N | Duration |
|---|---|---|---|---|---|---|---|---|
| | | | | h m | ° | h m | ° | h m |
| July | 7 | 88 Virginis | 6.5 | 21 19 | 63 | 22 3 | 354 | 0 44 |
| | 9 | 6 B. Librae | 6.2 | 0 22 | 171 | 0 54 | 228 | 0 32 |
| | 10 | Saturn | 0.5 | 16 30 | 88 | 17 31 | 325 | 1 1 |
| | 12 | 7 Sagittarii | 5.5 | 23 6 | 52 | 0 9 | 318 | 1 3 |
| | 12 | 9 Sagittarii | 6.0 | 23 40 | 66 | 0 55 | 299 | 1 15 |
| | 13 | 162 B. Sagittarii | 6.4 | 20 50 | 90 | 22 9 | 281 | 1 19 |
| | 13 | 127 G. Sagittarii | 6.4 | 22 2 | 94 | 23 26 | 269 | 1 25 |
| | 13 | 172 B. Sagittarii | 5.8 | 23 20 | 69 | 0 41 | 286 | 1 21 |
| | 14 | 189 B. Sagittarii | 6.1 | 2 46 | 59 | 3 51 | 281 | 1 5 |
| | 14 | 308 B. Sagittarii | 6.3 | 19 2 | 74 | 20 0 | 290 | 0 59 |
| | 16 | $\chi$ Capricorni | 5.3 | 3 3 | 108 | 3 58 | 206 | 0 55 |
| | 17 | 161 B. Capricorni | 6.4 | 0 16 | 124 | 1 0 | 192 | 0 44 |
| | 22 | 389 B. Ceti | 6.3 | 0 2 | 76 | 0 55 | 234 | 0 53 |
| | 24 | 85 H. Tauri | 6.0 | 0 42 | 52 | 1 28 | 271 | 0 46 |
| | 24 | 234 B. Tauri | 6.0 | 2 27 | 67 | 3 23 | 250 | 0 57 |
| | 24 | $\epsilon$ Tauri | 3.6 | 4 8 | 112 | 4 54 | 201 | 0 46 |
| Aug. | 10 | 51 Sagittarii | 5.8 | 22 21 | 112 | 23 33 | 230 | 1 12 |
| | 12 | $\epsilon$ Capricorni | 4.7 | 22 33 | 83 | 23 51 | 236 | 1 18 |
| | 13 | $\kappa$ Capricorni | 4.8 | 2 1 | 78 | 3 9 | 229 | 1 8 |
| | 17 | 117 G. Piscium | 6.5 | 2 47 | 52 | 4 4 | 237 | 1 17 |
| | 18 | 147 B. Arietis | 5.8 | 22 5 | 79 | 22 54 | 236 | 0 49 |
| | 21 | 333 B. Tauri | 6.3 | 0 30 | 60 | 1 22 | 264 | 0 52 |
| | 21 | 105 Tauri | 6.0 | 2 16 | 21 | 2 56 | 300 | 0 40 |
| | 22 | 1 Geminorum | 4.3 | 1 21 | 51 | 2 9 | 284 | 0 48 |

## Saturn's Satellites.

[From the *American Ephemeris.*]

CENTRAL STANDARD TIME, MIDNIGHT = $0^h$

I. Mimas. Period $0^d$ $22^h6$.

| 1927 | d | h | | d | h | | d | h | | d | h | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| July | 3 | 3.6 | E | 8 | 19.3 | E | 16 | 19.5 | W | 23 | 21.2 | E |
| | 4 | 2.2 | E | 12 | 2.4 | W | 20 | 2.7 | E | 24 | 19.8 | E |
| | 5 | 0.8 | E | 13 | 1.0 | W | 21 | 1.3 | E | 29 | 1.5 | W |
| | 5 | 23.4 | E | 13 | 23.6 | W | 21 | 23.9 | E | 30 | 0.2 | W |
| | 6 | 22.1 | E | 14 | 22.3 | W | 22 | 22.6 | E | 30 | 22.8 | W |
| | 7 | 20.7 | E | 15 | 20.9 | W | | | | | | |
| Aug. | 0 | 21.4 | W | 8 | 21.7 | E | 15 | 23.3 | W | 23 | 23.7 | E |
| | 1 | 20.0 | W | 9 | 20.3 | E | 16 | 22.0 | W | 24 | 22.3 | E |
| | 6 | 1.8 | E | 10 | 18.9 | E | 17 | 20.6 | W | 25 | 20.9 | E |
| | 7 | 0.5 | E | 15 | 0.7 | W | 18 | 19.2 | W | 26 | 19.5 | E |
| | 7 | 23.1 | E | | | | | | | | | |

II. Enceladus. Period $1^d$ $8^h9$.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| July | 1 | 4.0 | E | 9 | 9.3 | E | 17 | 14.6 | E | 25 | 19.9 | E |
| | 2 | 12.9 | E | 10 | 18.2 | E | 18 | 23.5 | E | 27 | 4.8 | E |
| | 3 | 21.8 | E | 12 | 3.1 | E | 20 | 8.4 | E | 28 | 13.7 | E |
| | 5 | 6.7 | E | 13 | 12.0 | E | 21 | 17.3 | E | 29 | 22.6 | E |
| | 6 | 15.5 | E | 14 | 20.8 | E | 23 | 2.1 | E | 31 | 7.4 | E |
| | 8 | 0.4 | E | 16 | 5.7 | E | 24 | 11.0 | E | | | |
| Aug. | 1 | 16.3 | E | 8 | 12.8 | E | 15 | 9.3 | E | 23 | 14.6 | E |
| | 3 | 1.2 | E | 9 | 21.7 | E | 16 | 18.2 | E | 24 | 23.5 | E |
| | 4 | 10.1 | E | 11 | 6.6 | E | 18 | 3.1 | E | 26 | 8.4 | E |
| | 5 | 19.0 | E | 12 | 15.5 | E | 19 | 12.0 | E | 27 | 17.3 | E |
| | 7 | 3.9 | E | 14 | 0.4 | E | 20 | 20.9 | E | 29 | 2.2 | E |
| | | | | | | | 22 | 5.8 | E | 30 | 11.1 | E |

III. Tethys. Period $1^d\ 21^h3$.

| 1927 | d | h | | d | h | | d | h | | d | h | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| July | 1 | 6.9 | E | 8 | 20.1 | E | 16 | 9.3 | E | 23 | 22.5 | E |
| | 3 | 4.2 | E | 10 | 17.4 | E | 18 | 6.6 | E | 25 | 19.8 | E |
| | 5 | 1.5 | E | 12 | 14.7 | E | 20 | 3.9 | E | 27 | 17.1 | E |
| | 6 | 22.8 | E | 14 | 12.0 | E | 22 | 1.2 | E | 29 | 14.4 | E |
| | | | | | | | | | | 31 | 11.7 | E |
| Aug. | 2 | 9.0 | E | 9 | 22.3 | E | 17 | 11.5 | E | 25 | 0.8 | E |
| | 4 | 6.4 | E | 11 | 19.6 | E | 19 | 8.9 | E | 26 | 22.1 | E |
| | 6 | 3.7 | E | 13 | 16.9 | E | 21 | 6.2 | E | 28 | 19.4 | E |
| | 8 | 1.0 | E | 15 | 14.2 | E | 23 | 3.5 | E | 30 | 16.8 | E |

IV. Dione. Period $2^d\ 17^h7$.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| July | 1 | 2.4 | E | 9 | 7.4 | E | 17 | 12.4 | E | 25 | 17.5 | E |
| | 3 | 20.1 | E | 12 | 1.1 | E | 20 | 6.1 | E | 28 | 11.1 | E |
| | 6 | 13.8 | E | 14 | 18.7 | E | 22 | 23.8 | E | 31 | 4.8 | E |
| Aug. | 2 | 22.5 | E | 11 | 3.6 | E | 19 | 8.6 | E | 27 | 13.7 | E |
| | 5 | 16.2 | E | 13 | 21.2 | E | 22 | 2.3 | E | 30 | 7.5 | E |
| | 8 | 9.9 | E | 16 | 14.9 | E | 24 | 20.0 | E | | | |

V. Rhea. Period $4^d\ 12^h5$.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| July | 3 | 13.9 | E | 12 | 14.6 | E | 21 | 15.3 | E | 30 | 16.2 | E |
| | 8 | 2.2 | E | 17 | 2.9 | E | 26 | 3.8 | E | | | |
| Aug. | 4 | 4.6 | E | 13 | 5.5 | E | 22 | 6.3 | E | 31 | 7.3 | E |
| | 8 | 17.0 | E | 17 | 17.9 | E | 26 | 18.8 | E | | | |

VI. Titan. Period $15^d\ 23^h3$.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| July | 6 | 10.2 | E | 14 | 13.1 | W | 22 | 8.3 | E | 30 | 11.3 | W |
| Aug. | 7 | 6.8 | E | 15 | 10.1 | W | 23 | 5.8 | E | 31 | 9.4 | W |

VII. Hyperion. Period $21^d\ 7^h6$.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| July | 9 | 12.1 | E | July | 21 | 7.5 | W | July | 30 | 15.2 | E | |
| | | | | Aug. | 11 | 11.4 | W | Aug. | 20 | 19.1 | E | |

VIII. Japetus. Period $79^d\ 22^h1$.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| July | 12 | 13.1 | E | July | 31 | 7.3 | I | Aug. | 20 | 11.0 | W | |

NOTE:—E, Eastern Elongation; W, Western Elongation; S, Superior Conjunction (north of planet); I, Inferior Conjunction (south of planet).

## Phenomena of Jupiter's Satellites.

VISIBLE AT WASHINGTON.

[From the *American Ephemeris.*]

CENTRAL STANDARD TIME, MIDNIGHT = $0^h$

| 1927 | h | m | | | 1927 | h | m | | |
|---|---|---|---|---|---|---|---|---|---|
| Aug. 0 | 21 | 32 | I | Tr. I. | Aug. 8 | 2 | 15 | III | Sh. I. |
| | 22 | 14 | III | Sh. I. | | 22 | 49 | I | Oc. R. |
| | 22 | 38 | I | Sh. E. | 9 | 20 | 55 | II | Sh. E. |
| | 23 | 44 | I | Tr. E. | | 22 | 53 | II | Tr. E. |
| 1 | 1 | 14 | III | Sh. E. | 11 | 23 | 2 | III | Oc. R. |
| | 1 | 45 | II | Oc. R. | 12 | 21 | 54.8 | IV | Ec. D. |
| | 3 | 4 | III | Tr. I. | 13 | 0 | 45.2 | IV | Ec. R. |
| 7 | 1 | 3.6 | I | Ec. D. | 14 | 2 | 58.1 | I | Ec. D. |
| 7 | 22 | 18 | I | Sh. I. | 15 | 0 | 11 | I | Sh. I. |
| | 23 | 20 | I | Tr. I | | 1 | 6 | I | Tr. I. |
| | 23 | 28.9 | II | Ec. D. | | 2 | 3.6 | II | Ec. D. |
| 8 | 0 | 31 | I | Sh. E. | | 2 | 25 | I | Sh. E. |
| | 1 | 31 | I | Tr. E. | | 3 | 18 | I | Tr. E. |

PHENOMENA OF JUPITER'S SATELLITES—Continued.

| 1927 | h | m | | | 1927 | h | m | | |
|---|---|---|---|---|---|---|---|---|---|
| Aug. 15 | 21 | 26.7 | I | Ec. D. | Aug. 23 | 22 | 48 | I | Sh. E. |
| 16 | 0 | 35 | I | Oc. R. | | 23 | 29 | II | Sh. I. |
| | 20 | 52 | II | Sh. I. | | 23 | 30 | I | Tr. E. |
| | 20 | 54 | I | Sh. E. | 24 | 1 | 2 | II | Tr. I. |
| | 21 | 44 | I | Tr. E. | | 2 | 9 | II | Sh. E. |
| | 22 | 43 | II | Tr. I. | | 3 | 34 | II | Tr. E. |
| | 23 | 32 | II | Sh. E. | | 20 | 47 | I | Oc. R. |
| 17 | 1 | 14 | II | Tr. E. | 25 | 21 | 52 | II | Oc. R. |
| 18 | 20 | 21.2 | III | Ec. D. | 26 | 0 | 23.2 | III | Ec. D. |
| | 23 | 20.7 | III | Ec. R. | 29 | 3 | 59 | I | Sh. I. |
| | 23 | 57 | III | Oc. D. | | 19 | 27 | III | Tr. E. |
| 19 | 2 | 30 | III | Oc. R. | 30 | 1 | 16.0 | I | Ec. D. |
| 22 | 2 | 5 | I | Sh. I. | | 22 | 28 | I | Sh. I |
| | 2 | 52 | I | Tr. I. | | 23 | 2 | I | Tr. I. |
| | 23 | 21.3 | I | Ec. D. | 31 | 0 | 42 | I | Sh. E. |
| 23 | 2 | 21 | I | Oc. R. | | 1 | 14 | I | Tr. E. |
| | 20 | 34 | I | Sh. I. | | 2 | 7 | II | Sh. I. |
| | 21 | 18 | I | Tr. I. | | 3 | 20 | II | Tr. I. |

NOTE:—I. denotes ingress; E., egress; D., disappearance; R., reappearance; Ec., eclipse; Oc., occultation; Tr., transit of the satellite; Sh., transit of the shadow.

## VARIABLE STARS.

### Maxima of Variable Stars of Short Period.

**[Calculated by members of the classes in Astronomy at Carleton College.]**

**Given to the nearest hour in Greenwich civil time; to obtain Eastern Standard time subtract 5$^h$; Central Standard time 6$^h$, etc.**

| Star | R.A. 1900 | | Decl. 1900 | | Magnitude | Approx. Period | | Greenwich civil times of maxima in 1927 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | July | | | | August | | | |
| | h | m | ° | ′ | | d | h | d | h | d | h | d | h | d | h |
| SX Cassiop. | 0 | 05.5 | +54 | 20 | 8.6— 9.2 | 36 | 13.7 | | | 18 | 6 | | | 23 | 20 |
| SY Cassiop. | 0 | 09.8 | +57 | 52 | 9.3— 9.9 | 4 | 01.7 | 6 | 22 | 23 | 5 | 8 | 11 | 24 | 18 |
| RR Ceti | 1 | 27.0 | + 0 | 50 | 8.3— 9.0 | 0 | 13.3 | 3 | 3 | 18 | 14 | 3 | 2 | 18 | 13 |
| RW Cassiop. | 1 | 30.7 | +57 | 15 | 8.9—11.0 | 14 | 19.2 | 7 | 20 | 22 | 15 | 6 | 10 | 21 | 5 |
| V Arietis | 2 | 09.6 | +11 | 46 | 8.3— 9.0 | 0 | 23.8 | 8 | 2 | 23 | 23 | 8 | 20 | 24 | 17 |
| SU Cassiop. | 2 | 43.0 | +68 | 28 | 6.5— 7.0 | 1 | 22.8 | 8 | 1 | 23 | 14 | 8 | 5 | 23 | 19 |
| RW Camelop. | 3 | 46.2 | +58 | 21 | 8.2— 9.4 | 16 | 00.0 | 12 | 19 | 29 | 5 | 14 | 14 | 31 | 0 |
| SX Persei | 4 | 10.2 | +41 | 27 | 10.4—11.2 | 4 | 07.0 | 8 | 11 | 25 | 14 | 3 | 4 | 20 | 8 |
| SV Persei | | 42.8 | +42 | 07 | 8.8— 9.6 | 11 | 03.1 | 2 | 20 | 25 | 2 | 5 | 6 | 27 | 12 |
| RX Aurigæ | 4 | 54.5 | +39 | 49 | 7.2— 8.1 | 11 | 15.0 | 8 | 23 | 20 | 13 | 1 | 4 | 24 | 10 |
| SX Aurigæ | 5 | 04.6 | +42 | 02 | 8.0— 8.7 | 1 | 12.8 | 6 | 23 | 22 | 7 | 6 | 15 | 21 | 23 |
| SY Aurigæ | | 05.5 | +42 | 41 | 8.4— 9.5 | 10 | 03.3 | 9 | 22 | 30 | 5 | 9 | 8 | 29 | 15 |
| Y Aurigæ | | 21.5 | +42 | 21 | 8.6— 9.6 | 3 | 20.6 | 7 | 14 | 23 | 15 | 7 | 11 | 22 | 21 |
| RZ Gemin. | 5 | 56.6 | +22 | 15 | 9.1—10.0 | 5 | 12.7 | 8 | 18 | 19 | 20 | 5 | 10 | 27 | 13 |
| RS Orionis | 6 | 16.5 | +14 | 44 | 8.2— 8.9 | 7 | 13.6 | 7 | 21 | 23 | 0 | 7 | 3 | 22 | 6 |
| T Monoc. | | 19.8 | + 7 | 08 | 5.7— 6.8 | 27 | 00.3 | | | 22 | 12 | | | 18 | 12 |
| RT Aurigæ | | 23.0 | +30 | 33 | 5.1— 6.0 | 3 | 17.5 | 8 | 0 | 22 | 22 | 6 | 20 | 21 | 17 |
| W Gemin. | | 29.2 | +15 | 24 | 6.7— 7.5 | 7 | 22.0 | 7 | 15 | 23 | 11 | 8 | 7 | 24 | 3 |
| ζ Gemin. | 6 | 58.2 | +20 | 43 | 3.7— 4.3 | 10 | 03.7 | 5 | 12 | 25 | 19 | 4 | 23 | 25 | 6 |
| RU Camelop. | 7 | 10.9 | +69 | 51 | 8.5— 9.8 | 22 | 06.5 | | | 18 | 23 | 10 | 5 | | |
| RR Gemin. | 7 | 15.2 | +31 | 04 | 10.0—11.5 | 0 | 09.5 | 9 | 11 | 25 | 8 | 10 | 5 | 26 | 3 |
| V Carinæ | 8 | 26.7 | —59 | 47 | 7.4— 8.1 | 6 | 16.7 | 7 | 23 | 21 | 8 | 3 | 17 | 17 | 2 |

**Maxima of Variable Stars of Short Period—Continued.**

| Star | R.A. 1900 | Decl. 1900 | Magnitude | Approx. Period | Greenwich civil times of maxima in 1927 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | July | | | | August | | | |
| | h m | ° ′ | | d h | d h | d h | d h | d h | d h | d h | d h | d h |
| T Velorum | 8 34.4 | −47 01 | 7.6— 8.5 | 4 15.3 | 9 19 | 23 17 | 6 15 | 20 13 | | | | |
| V Velorum | 9 19.2 | −55 32 | 7.5— 8.2 | 4 08.9 | 4 11 | 21 23 | 8 11 | 25 22 | | | | |
| Z Leonis | 9 46.4 | +27 22 | 7.9— 9.6 | 56 08.7 | | | 12 12 | | | | | |
| RR Leonis | 10 02.1 | +24 29 | 9.1—10.1 | 0 10.9 | 9 12 | 23 1 | 5 15 | 17 5 | | | | |
| SU Draconis | 11 32.2 | +67 53 | 8.9— 9.6 | 0 15.8 | 9 12 | 22 17 | 11 12 | 24 18 | | | | |
| S Muscæ | 12 07.4 | −69 36 | 6.4— 7.3 | 9 15.8 | 1 7 | 20 15 | 8 22 | 28 6 | | | | |
| SW Draconis | 12.8 | +70 04 | 8.8— 9.6 | 0 13.7 | 3 9 | 19 8 | 4 7 | 20 6 | | | | |
| T Crucis | 15.9 | −61 44 | 6.8— 7.6 | 6 17.6 | 4 13 | 24 17 | 7 5 | 20 16 | | | | |
| R Crucis | 18.1 | −61 04 | 6.8— 7.9 | 5 19.8 | 7 22 | 25 10 | 6 1 | 23 13 | | | | |
| S Crucis | 12 48.4 | −57 53 | 6.5— 7.6 | 4 16.6 | 6 11 | 20 13 | 8 8 | 22 9 | | | | |
| W Virginis | 13 20.9 | − 2 52 | 8.7—10.4 | 17 06.5 | 12 20 | 30 3 | 16 9 | | | | | |
| SS Hydræ | 25.0 | −23 08 | 7.4— 8.1 | 8 04.8 | 8 22 | 25 8 | 10 17 | 27 3 | | | | |
| RV Urs. Maj. | 13 29.4 | +54 31 | 9.2— 9.9 | 0 11.2 | 10 9 | 24 10 | 7 11 | 21 12 | | | | |
| ST Virginis | 14 22.5 | − 0 27 | 10.3—11.4 | 0 09.9 | 9 3 | 23 22 | 7 18 | 22 13 | | | | |
| V Centauri | 25.4 | −56 27 | 6.4— 7.8 | 5 11.9 | 6 23 | 23 10 | 8 22 | 19 21 | | | | |
| RS Bootis | 29.3 | +32 11 | 8.9—10.0 | 0 09.1 | 12 4 | 27 6 | 11 8 | 26 10 | | | | |
| R Trian.Austr. | 15 10.8 | −66 08 | 6.7— 7.4 | 3 09.3 | 6 0 | 19 13 | 8 21 | 22 11 | | | | |
| S Trian.Austr. | 15 52.2 | −63 29 | 6.4— 7.4 | 6 07.8 | 9 8 | 21 23 | 9 22 | 22 14 | | | | |
| S Normæ | 16 10.6 | −57 39 | 6.6— 7.6 | 9 18.1 | 3 7 | 22 19 | 11 7 | 30 19 | | | | |
| RW Draconis | 33.7 | +58 03 | 9.6—10.8 | 0 10.6 | 8 15 | 26 8 | 13 1 | 30 18 | | | | |
| RV Scorpii | 16 51.8 | −33 27 | 6.7— 7.4 | 6 01.5 | 9 14 | 21 17 | 8 22 | 21 1 | | | | |
| X Sagittarii | 17 41.3 | −27 48 | 4.4— 5.0 | 7 00.3 | 6 10 | 20 10 | 3 11 | 24 11 | | | | |
| Y Ophiuchi | 47.3 | − 6 07 | 6.1— 6.5 | 17 02.9 | | 17 6 | 3 9 | 20 12 | | | | |
| W Sagittarii | 17 58.6 | −29 35 | 4.3— 5.1 | 7 14.3 | 2 4 | 17 8 | 9 3 | 24 8 | | | | |
| Y Sagittarii | 18 15.5 | −18 54 | 5.4— 6.2 | 5 18.6 | 8 23 | 20 12 | 6 20 | 24 4 | | | | |
| U Sagittarii | 26.0 | −19 12 | 6.5— 7.3 | 6 17.9 | 4 7 | 24 13 | 7 0 | 20 12 | | | | |
| Y Scuti | 32.6 | − 8 27 | 8.7— 9.2 | 10 08.3 | 9 8 | 30 0 | 9 9 | 30 1 | | | | |
| RZ Lyræ | 39.9 | +32 42 | 9.9—11.2 | 0 12.3 | 7 5 | 22 13 | 6 21 | 22 5 | | | | |
| RT Scuti | 18 44.1 | −10 30 | 9.1— 9.7 | 0 11.9 | 5 13 | 20 10 | 4 6 | 19 3 | | | | |
| κ Pavonis | 18 46.6 | −67 22 | 3.8— 5.2 | 9 02.2 | 5 3 | 23 7 | 10 11 | 28 16 | | | | |
| U Aquilæ | 19 24.0 | − 7 15 | 6.2— 6.9 | 7 00.6 | 6 11 | 20 12 | 10 14 | 24 15 | | | | |
| XZ Cygni | 19 30.4 | +56 10 | 8.6— 9.3 | 0 11.2 | 4 3 | 18 3 | 8 3 | 22 3 | | | | |
| U Vulpec. | 32.2 | +20 07 | 6.5— 7.6 | 7 23.5 | 7 13 | 23 12 | 8 11 | 24 10 | | | | |
| SU Cygni | 40.8 | +29 01 | 6.2— 7.0 | 3 20.3 | 9 1 | 24 10 | 8 19 | 24 4 | | | | |
| η Aquilæ | 47.4 | + 0 45 | 3.7— 4.5 | 7 04.2 | 6 10 | 20 18 | 11 7 | 25 16 | | | | |
| S Sagittæ | 51.5 | +16 22 | 5.6— 6.4 | 8 09.2 | 6 1 | 22 19 | 8 14 | 25 8 | | | | |
| X Vulpec. | 19 53.3 | +26 17 | 9.5—10.5 | 6 07.7 | 10 15 | 23 6 | 10 6 | 23 21 | | | | |
| X Cygni | 20 39.5 | +35 14 | 6.0— 7.0 | 16 09.3 | 7 4 | 23 13 | 8 22 | 25 7 | | | | |
| T Vulpec. | 47.2 | +27 52 | 5.5— 6.1 | 4 10.5 | 5 20 | 23 14 | 10 8 | 28 2 | | | | |
| UY Cygni | 52.3 | +30 03 | 9.6—10.4 | 0 13.5 | 4 19 | 19 9 | 2 23 | 17 13 | | | | |
| RV Capric. | 55.9 | −15 37 | 9.2—10.1 | 0 10.7 | 7 20 | 22 4 | 5 12 | 19 20 | | | | |
| TX Cygni | 20 56.4 | +42 12 | 8.5— 9.7 | 14 17.4 | 10 2 | 24 19 | 8 12 | 23 5 | | | | |
| VY Cygni | 21 00.4 | +39 34 | 8.8— 9.5 | 7 20.6 | 9 16 | 25 9 | 2 6 | 17 23 | | | | |
| SW Aquarii | 10.2 | − 0 20 | 9.9—10.8 | 0 11.0 | 7 19 | 21 14 | 4 9 | 18 3 | | | | |
| VZ Cygni | 21 47.7 | +42 40 | 8.2— 9.2 | 4 20.7 | 6 9 | 25 20 | 4 13 | 24 0 | | | | |
| Y Lacertæ | 22 05.2 | +50 33 | 9.1— 9.6 | 4 07.8 | 2 14 | 19 22 | 6 5 | 23 12 | | | | |
| δ Cephei | 25.5 | +57 54 | 3.7— 4.6 | 5 08.8 | 7 20 | 23 22 | 9 0 | 25 3 | | | | |
| Z Lacertæ | 36.9 | +56 18 | 8.2— 9.0 | 10 21.1 | 2 23 | 24 18 | 4 15 | 26 10 | | | | |
| RR Lacertæ | 37.5 | +55 55 | 8.5— 9.2 | 6 10.1 | 8 23 | 21 19 | 10 0 | 22 20 | | | | |
| V Lacertæ | 44.5 | +55 48 | 8.5— 9.5 | 4 23.6 | 2 5 | 22 3 | 11 2 | 31 0 | | | | |
| X Lacertæ | 22 45.0 | +55 54 | 8.2— 8.6 | 5 10.7 | 8 6 | 24 14 | 9 22 | 26 6 | | | | |
| SW Cassiop. | 23 03.7 | +58 11 | 9.2— 9.7 | 5 10.6 | 10 2 | 26 10 | 6 7 | 22 15 | | | | |
| RS Cassiop. | 32.6 | +61 52 | 9.0—11.0 | 6 07.1 | 10 0 | 22 14 | 10 11 | 23 1 | | | | |
| RY Cassiop. | 47.2 | +58 11 | 9.3—11.8 | 12 03.4 | 11 8 | 23 11 | 4 15 | 28 21 | | | | |
| V Cephei | 23 51.7 | +82 38 | 6.0— 7.0 | 0 23.9 | 9 18 | 23 18 | 6 17 | 20 16 | | | | |

## Minima of Variable Stars of Short Period.

[Calculated by members of the classes in Astronomy at Carleton College.]

Given to the nearest hour in Greenwich civil time; to obtain Eastern Standard time subtract $5^h$; Central Standard time $6^h$, etc.

| Star | R.A. 1900 | Decl. 1900 | Magnitude | Approx. Period | Greenwich civil times of Minima in 1927 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | July | | | | August | | | |
| | h m | ° ′ | | d h | d h | | d h | | d h | | d h | |
| SY Androm. | 0 08.0 | +43 09 | 9.5—13.0 | 34 21.8 | | | 30 | 20 | | | | |
| RT Sculptor. | 31.5 | —26 13 | 9.6—10.5 | 0 12.3 | 8 | 17 | 24 | 3 | 8 | 12 | 23 | 20 |
| U Cephei | 0 53.4 | +81 20 | 7.0— 9.0 | 2 11.8 | 4 | 19 | 19 | 18 | 11 | 5 | 26 | 4 |
| Z Persei | 2 33.7 | +41 46 | 9.4—12 | 3 01.4 | 7 | 11 | 25 | 19 | 13 | 3 | 25 | 8 |
| TW Cassiop. | 37.6 | +65 19 | 8.2— 9.0 | 1 10.3 | 11 | 6 | 28 | 9 | 6 | 0 | 23 | 3 |
| RY Persei | 39.0 | +47 43 | 8.0—10.3 | 6 20.7 | 9 | 20 | 23 | 13 | 6 | 7 | 20 | 1 |
| RZ Cassiop. | 39.9 | +69 13 | 6.9— 8.1 | 1 04.7 | 6 | 21 | 21 | 5 | 11 | 18 | 26 | 1 |
| TX Cassiop. | 44.4 | +62 22 | 9.4—10.1 | 2 22.2 | 9 | 0 | 26 | 13 | 13 | 3 | 30 | 16 |
| ST Persei | 53.7 | +38 47 | 8.5—10.5 | 2 15.6 | 4 | 16 | 20 | 13 | 5 | 11 | 21 | 8 |
| RX Cassiop. | 2 58.8 | +67 11 | 8.6— 9.1 | 32 07.6 | 11 | 10 | | | 12 | 17 | | |
| Algol | 3 01.7 | +40 34 | 2.3— 3.5 | 2 20.8 | 6 | 23 | 24 | 4 | 10 | 9 | 27 | 14 |
| RT Persei | 16.7 | +46 12 | 9.5—11.5 | 0 20.4 | 10 | 1 | 23 | 14 | 6 | 5 | 19 | 19 |
| λ Tauri | 55.1 | +12 12 | 3.3— 4.2 | 3 22.9 | 3 | 1 | 18 | 20 | 3 | 15 | 19 | 11 |
| RW Tauri | 3 57.8 | +27 51 | 7.1— [11 | 2 18.5 | 6 | 3 | 22 | 18 | 8 | 9 | 24 | 23 |
| RV Persei | 4 04.2 | +33 59 | 9.5—11.0 | 1 23.4 | 9 | 12 | 25 | 7 | 10 | 2 | 25 | 21 |
| RW Persei | 13.3 | +42 04 | 8.8—11.0 | 13 04.8 | 11 | 18 | 24 | 23 | 7 | 4 | 20 | 9 |
| SZ Tauri | 31.4 | +18 20 | 7.2— 7.7 | 3 03.6 | 6 | 16 | 25 | 13 | 7 | 3 | 26 | 1 |
| RS Cephei | 4 48 6 | +80 06 | 9.5—12.0 | 12 10.1 | 3 | 4 | 28 | 1 | 9 | 11 | 21 | 21 |
| TT Aurigae | 5 02.8 | +39 27 | 7.8— 8.7 | 0 16.0 | 10 | 23 | 24 | 7 | 6 | 14 | 19 | 22 |
| RY Aurigae | 11.5 | +38 13 | 10.7—11.7 | 2 17.5 | 4 | 12 | 20 | 21 | 6 | 5 | 22 | 14 |
| RZ Aurigae | 42.9 | +31 40 | 10.6—13.3 | 3 00.3 | 8 | 15 | 20 | 16 | 7 | 17 | 19 | 18 |
| SV Tauri | 45.8 | +28 05 | 9.4—11.0 | 2 04.0 | 9 | 20 | 27 | 4 | 13 | 12 | 30 | 20 |
| Z Orionis | 50.2 | +13 40 | 9.7—10.7 | 5 04.9 | 4 | 3 | 24 | 23 | 4 | 9 | 25 | 4 |
| SV Gemin. | 54.6 | +24 28 | 9.8— [11 | 4 00.2 | 10 | 15 | 26 | 16 | 11 | 16 | 27 | 17 |
| RW Gemin. | 5 55.4 | +23 08 | 9.5—11.0 | 2 20.8 | 9 | 12 | 20 | 23 | 7 | 3 | 24 | 8 |
| U Columbæ | 6 11.2 | —33 03 | 9.2—10.0 | 2 19.2 | 8 | 17 | 25 | 12 | 11 | 8 | 22 | 12 |
| SX Gemin. | 22.0 | +20 37 | 10.8—11.5 | 1 08.8 | 11 | 13 | 27 | 23 | 13 | 9 | 29 | 18 |
| RW Monoc. | 29.3 | + 8 54 | 9.0—10.8 | 1 21.7 | 14 | 20 | 30 | 2 | 14 | 8 | 29 | 14 |
| RX Gemin. | 43 6 | +33 21 | 8.8— 9.6 | 12 05.0 | 1 | 18 | 26 | 4 | 7 | 9 | 31 | 19 |
| RU Monoc. | 6 49.4 | — 7 28 | 9.8—10.5 | 0 21.5 | 9 | 22 | 24 | 6 | 7 | 14 | 21 | 23 |
| R Can. Maj. | 7 14.9 | —16 12 | 5.8— 6.4 | 1 03.3 | 6 | 16 | 20 | 7 | 9 | 18 | 23 | 9 |
| RY Gemin. | 21.7 | +15 52 | 8.9— [10 | 9 07.2 | 12 | 22 | 31 | 12 | 9 | 19 | 28 | 10 |
| Y Camelop. | 27.6 | +76 17 | 9.5—12 | 3 07.3 | 4 | 17 | 17 | 22 | 6 | 18 | 19 | 23 |
| TX Gemin. | 30.3 | +17 08 | 10.0—11.9 | 2 19.2 | 3 | 11 | 20 | 6 | 6 | 1 | 22 | 20 |
| RR Puppis | 43.5 | —41 08 | 9.4—10.7 | 6 10.3 | 10 | 5 | 23 | 1 | 11 | 8 | 24 | 5 |
| V Puppis | 7 55.4 | —48 58 | 4.1— 4.8 | 1 10.9 | 10 | 3 | 24 | 16 | 15 | 12 | 30 | 16 |
| X Carinæ | 8 29.1 | —58 53 | 7.9— 8.7 | 0 13.0 | 3 | 19 | 20 | 1 | 5 | 6 | 21 | 11 |
| S Cancri | 8 38.2 | +19 24 | 8.2—10 | 9 11.6 | 11 | 0 | 29 | 23 | 8 | 11 | 27 | 10 |
| RX Hydræ | 9 00.8 | — 7 52 | 9.1—10.5 | 2 06.8 | 8 | 4 | 21 | 21 | 11 | 10 | 25 | 2 |
| S Velorum | 29.4 | —44 46 | 7.8— 9.3 | 5 22.4 | 11 | 3 | 23 | 1 | 9 | 19 | 21 | 16 |
| Y Leonis | 9 31.1 | +26 41 | 9.3—11.2 | 1 16.5 | 7 | 2 | 20 | 14 | 9 | 19 | 23 | 7 |
| RR Velorum | 10 17.8 | —41 36 | 10.0—10.9 | 1 20.5 | 13 | 14 | 28 | 10 | 4 | 20 | 19 | 16 |
| SS Carinæ | 10 54.2 | —61 23 | 12.2—12.8 | 3 07.2 | 4 | 18 | 24 | 13 | 6 | 18 | 19 | 23 |
| ST Urs. Maj. | 11 22.4 | +45 44 | 6.7— 7.2 | 8 19.2 | 5 | 3 | 22 | 17 | 9 | 8 | 26 | 22 |
| RW Urs. Maj. | 35.4 | +52 34 | 10.3—11.4 | 7 07.9 | 8 | 12 | 23 | 3 | 6 | 19 | 21 | 11 |
| Z Draconis | 11 39.8 | +72 49 | 9.9—13.6 | 1 08.6 | 5 | 15 | 19 | 5 | 8 | 14 | 22 | 3 |
| RZ Centauri | 12 55.6 | —64 05 | 8.5— 8.9 | 1 21.0 | 2 | 7 | 17 | 7 | 8 | 19 | 23 | 20 |
| RS Can. Ven. | 13 06.3 | +36 28 | 7.5—12.5 | 4 19.1 | 5 | 6 | 24 | 10 | 3 | 1 | 22 | 5 |
| SS Centauri | 07.2 | —63 37 | 8.8—10.4 | 2 11.5 | 9 | 10 | 24 | 7 | 8 | 4 | 23 | 1 |

**Minima of Variable Stars of Short Period—Continued.**

| Star | R.A. 1900 | Decl. 1900 | Magnitude | Approx. Period | Greenwich civil times of Minima in 1927 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | July | | | | August | | | |
| | h m | ° ′ | | d h | d h | d h | d h | d h | d h | d h | d h | d h |
| SX Hydræ | 13 39.0 | −26 23 | 8.6—12.7 | 2 21.5 | 6 1 | 23 10 | 9 19 | 27 4 | | | | |
| δ Libræ | 14 55.6 | − 8 07 | 4.8— 6.2 | 2 07.9 | 4 3 | 18 2 | 7 1 | 22 0 | | | | |
| U Coronæ | 15 14.1 | +32 01 | 7.6— 8.7 | 3 10.9 | 6 8 | 20 3 | 9 21 | 23 16 | | | | |
| TW Draconis | 15 32.4 | +64 14 | 7.3— 8.9 | 2 19.4 | 10 21 | 27 17 | 5 3 | 21 23 | | | | |
| SS Libræ | 15 43.4 | −15 14 | 9.3—11.5 | 0 18.4 | 7 0 | 21 9 | 11 23 | 26 8 | | | | |
| SW Ophiuchi | 16 11.1 | − 6 44 | 9.2—10.0 | 2 10.7 | 6 20 | 21 12 | 5 4 | 19 2 | | | | |
| SX Ophiuchi | 12.6 | − 6 25 | 10.5—11.2 | 2 01.5 | 2 7 | 18 20 | 4 7 | 20 19 | | | | |
| R Aræ | 31.1 | −56 48 | 6.8— 7.9 | 4 10.2 | 8 18 | 24 12 | 4 8 | 22 1 | | | | |
| TT Herculis | 16 49.9 | +17 00 | 8.9— 9.3 | 20 18.1 | 3 1 | 23 19 | 13 14 | | | | | |
| TU Herculis | 17 09.8 | +30 50 | 9.5—12 | 2 06.4 | 4 11 | 18 2 | 7 11 | 21 2 | | | | |
| U Ophiuchi | 11.5 | + 1 19 | 6.0— 6.7 | 1 16.2 | 3 9 | 20 3 | 6 22 | 22 16 | | | | |
| u Herculis | 13.6 | +33 12 | 4.6— 5.4 | 2 01.2 | 3 1 | 21 12 | 8 23 | 21 6 | | | | |
| TX Herculis | 15.4 | +42 00 | 8.3— 9.0 | 2 01.4 | 9 1 | 21 10 | 8 23 | 21 7 | | | | |
| RV Ophiuchi | 29.8 | + 7 19 | 9. —12 | 3 16.5 | 5 4 | 19 22 | 11 0 | 25 19 | | | | |
| SZ Herculis | 36.0 | +33 01 | 9.5—10.3 | 0 19.6 | 4 1 | 20 10 | 5 19 | 22 4 | | | | |
| TX Scorpii | 48.6 | −34 13 | 7.5— 8.2 | 0 22.6 | 7 10 | 22 12 | 6 14 | 21 15 | | | | |
| UX Herculis | 49.7 | +16 57 | 8.8—10.5 | 1 13.2 | 3 15 | 19 2 | 3 14 | 19 2 | | | | |
| Z Herculis | 53.6 | +15 09 | 7.1— 7.9 | 3 23.8 | 7 5 | 23 5 | 8 4 | 24 3 | | | | |
| WX Sagittarii | 53.6 | −17 24 | 9.2—10.8 | 2 03.1 | 4 8 | 21 8 | 7 9 | 24 10 | | | | |
| WY Sagittarii | 17 54.9 | −23 01 | 9.5—10.6 | 4 16.0 | 6 5 | 20 5 | 7 21 | 21 22 | | | | |
| SX Draconis | 18 03.0 | +58 23 | 9.3—10.5 | 5 04.1 | 6 0 | 21 12 | 7 0 | 21 12 | | | | |
| RS Sagittarii | 11.0 | −34 08 | 5.9— 6.3 | 2 10.0 | 3 16 | 18 4 | 8 22 | 23 9 | | | | |
| V Serpentis | 11.1 | −15 34 | 9.5—11.1 | 3 10.9 | 5 6 | 19 2 | 8 19 | 22 15 | | | | |
| RZ Scuti | 21.1 | − 9 15 | 7.4— 8.3 | 15 03.2 | 10 7 | 25 10 | 9 13 | 24 16 | | | | |
| RZ Draconis | 21.8 | +58 50 | 9.5—10.2 | 0 13.2 | 5 16 | 20 0 | 10 11 | 24 19 | | | | |
| RX Herculis | 26.0 | +12 32 | 7.0— 7.6 | 0 21.3 | 3 23 | 18 4 | 8 12 | 22 18 | | | | |
| SX Sagittarii | 39.7 | −30 36 | 8.7— 9.8 | 2 01.8 | 6 14 | 23 5 | 8 20 | 25 11 | | | | |
| RR Draconis | 40.8 | +62 34 | 9.3—13 | 2 19.9 | 8 8 | 25 8 | 11 7 | 28 7 | | | | |
| RS Scuti | 43.7 | −10 21 | 9.3—10.3 | 0 15.9 | 9 10 | 22 17 | 5 0 | 24 22 | | | | |
| β Lyræ | 46.4 | +33 15 | 3.4— 4.1 | 12 21.8 | 3 10 | 29 6 | 11 4 | 24 | | | | |
| U Scuti | 18 48.9 | −12 44 | 9.1— 9.6 | 0 22.9 | 11 22 | 27 5 | 11 12 | 26 18 | | | | |
| RX Draconis | 19 01.1 | +58 35 | 9.3—10.2 | 1 21.4 | 9 20 | 24 23 | 9 3 | 21 20 | | | | |
| RV Lyræ | 12.5 | +32 15 | 11. —12.8 | 3 14.4 | 4 14 | 19 0 | 9 14 | 24 0 | | | | |
| RS Vulpec. | 13.4 | +22 16 | 6.9— 8.0 | 4 11.4 | 4 21 | 22 18 | 9 16 | 27 14 | | | | |
| U Sagittæ | 14.4 | +19 26 | 6.5— 9.0 | 3 09.1 | 9 22 | 23 11 | 12 18 | 26 6 | | | | |
| Z Vulpec. | 17.5 | +25 23 | 7.3— 8.5 | 2 10.9 | 4 6 | 19 0 | 10 2 | 24 19 | | | | |
| TT Lyræ | 24.3 | +41 30 | 9.4—11.6 | 5 05.8 | 9 16 | 25 9 | 10 3 | 25 20 | | | | |
| UZ Draconis | 26.1 | +68 44 | 9.0— 9.8 | 1 15.1 | 4 18 | 24 7 | 6 9 | 19 10 | | | | |
| SY Cygni | 19 42.7 | +32 28 | 10. —12 | 6 00.2 | 8 19 | 26 19 | 7 20 | 25 | | | | |
| WW Cygni | 20 00.6 | +41 18 | 9.3—13.4 | 3 07.6 | 5 1 | 24 23 | 7 5 | 20 12 | | | | |
| SW Cygni | 03.8 | +46 01 | 9. —11.7 | 4 13.8 | 9 20 | 18 23 | 6 6 | 20 0 | | | | |
| VW Cygni | 11.4 | +34 12 | 9.8—11.8 | 8 10.3 | 4 2 | 20 22 | 6 19 | 23 16 | | | | |
| RW Capric. | 12.2 | −17 59 | 8.8—10.6 | 3 09.4 | 9 9 | 22 23 | 5 12 | 19 2 | | | | |
| UW Cygni | 19.6 | +42 55 | 10.5—13 | 3 10.8 | 4 20 | 25 13 | 8 8 | 22 4 | | | | |
| V Vulpec. | 32.3 | +26 15 | 8.2— 9.8 | 37 19.0 | 3 19 | | 10 14 | | | | | |
| W Delphini | 33.1 | +17 56 | 9.4—12.1 | 4 19.4 | 3 23 | 23 5 | 6 15 | 21 1 | | | | |
| RR Delphini | 38.9 | +13 35 | 10.5—11.8 | 4 14.4 | 7 9 | 25 19 | 4 0 | 22 9 | | | | |
| Y Cygni | 48.1 | +34 17 | 7.1— 7.9 | 2 23.9 | 5 17 | 23 17 | 10 16 | 28 15 | | | | |
| WZ Cygni | 49.3 | +38 27 | 9.9—10.8 | 0 14.0 | 6 17 | 21 22 | 6 3 | 21 7 | | | | |
| RR Vulpec. | 20 50.5 | +27 32 | 9.6—11.0 | 5 01.2 | 3 19 | 24 1 | 3 3 | 23 7 | | | | |
| RY Aquarii | 21 14.8 | −11 14 | 8.8—10.4 | 1 23.2 | 5 20 | 21 13 | 6 7 | 22 1 | | | | |
| UZ Cygni | 55.2 | +43 52 | 8.9—11.6 | 31 07.3 | 11 4 | | 11 12 | | | | | |
| RT Lacertæ | 21 57.4 | +43 24 | 9.1—10.5 | 5 01.7 | 3 17 | 18 22 | 8 5 | 23 10 | | | | |
| RW Lacertæ | 22 40.6 | +49 08 | 10.2—11.2 | 5 04.4 | 9 14 | 25 4 | 9 17 | 25 6 | | | | |
| VW Pegasi | 51.7 | +32 42 | 10.0—10.6 | 5 06.4 | 8 0 | 23 19 | 8 14 | 24 10 | | | | |
| Y Piscium | 23 29.3 | + 7 22 | 9.0—12.0 | 3 18.4 | 15 22 | 31 0 | 7 12 | 22 14 | | | | |
| TW Androm. | 23 58.2 | +32 17 | 8.6—11.5 | 4 02.9 | 3 9 | 19 21 | 5 9 | 21 21 | | | | |

## Monthly Report of the American Association of Variable Star Observers, for the Month ending April 30, 1927.

The following have been elected to active membership in the Association by recent action of the Council. Several of them have been contibuting to these columns for some months past.

Margaret L. Walton, Cambridge, Mass.
Ingeborg Jonsson, Northampton, Mass.
Elbert Greenberg, Cincinnati, Ohio.
John S. Paraskevoupolos, Bloemfontein, So. Africa.
Albert W. Recht, Denver, Colorado.

The observations of Fr. E. C. Phillips are, at his request, listed under the Georgetown College Observatory; abbreviation. GC. The College of the City of New York is represented by Messrs. Wolff and Rittenberg, who contribute for the first time to our reports. Secretary Olcott officially represented the Association at the Annual Dinner of the Bond Astronomical Club, held in Boston on May 7. Our own Honorary member, Professor H. H. Turner, of Oxford, England, was the guest of honor of the Club on that same occasion.

In the preparation of these reports, especially when time is short in which to send off copy to the printer, and with the large number of observations to be handled by the recording secretary and his assistant, unavoidable errors are found to creep into the work. Some of these errors are trivial, others more serious, particularly where magnitudes are involved, but the forbearance of the observers is asked, and we hope that those who find such errors will notify headquarters, so that they may be corrected in the addenda to be printed at the end of the annual summary.

The following observers have contributed to the results here presented: Miss Allen, "Ae"; Messrs. Allen, "Al"; Baldwin. "Bl"; Bappu, "Bf"; Berman, "Bi";

### Rapidly Varying Irregular Variables.

| Star | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|
| 005840 RX Andromedae— | | | | | | |
| | 4962.6 | [12.4 | Pt | 4968.6 | [11.7 | Pt |
| 060547 SS Aurigae— | | | | | | |
| | 4914.1 | 15.1 | Bg | 4961.6 | [13.3 | Lv |
| | 4917.1 | 14.8 | Bg | 4962.3 | 13.9 | L |
| | 4918.1 | 14.8 | Bg | 4964.7 | 14.5 | Rh |
| | 4920.1 | 14.8 | Bg | 4968.7 | 14.4 | Rh |
| | 4931.1 | 14.8 | Bg | 4969.6 | [13.5 | B |
| | 4934.1 | 14.8 | Bg | 4971.7 | 14.5 | Rh |
| | 4936.2 | 11.3 | Bf | 4974.7 | [12.6 | Sg |
| | 4936.2 | 11 0 | Ch | 4975.6 | [13 6 | Cd |
| | 4937.1 | 10.7 | Bf | 4976.6 | [12.6 | Pt |
| | 4937.2 | 10.7 | Ch | 4977.7 | [12.4 | Pt |
| | 4939.1 | 10.9 | Bf | 4978.5 | [12.6 | Ie |
| | 4944.2 | [13.0 | L | 4981.5 | [12.6 | Ie |
| | 4950.3 | [13.3 | L | 4982.6 | [12.4 | Pt |
| | 4953.3 | 13.6 | L | 4984.7 | [12.4 | Pt |
| | 4957.3 | [12 4 | L | 4986.6 | [11.0 | Cl |
| | 4959.4 | [12.4 | L | 4987.8 | [11.5 | Pt |
| | 4960 7 | [12.4 | Sg | 4989.6 | [12.6 | Pt |

| Star | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|
| 074922 U Geminorum— | | | | | | |
| | 4937.1 | [12.3 | Ch | 4967.6 | 14.0 | B |
| | 4941.2 | [12.4 | Ch | 4968.7 | 14.3 | Rh |
| | 4942.1 | [12.4 | Ch | 4969.6 | [12.3 | Pt |
| | 4943.2 | [12.4 | Ch | 4971.7 | 14.3 | Rh |
| | 4944.2 | [12.4 | Ch | 4972.6 | [13.7 | B |
| | 4946.2 | [12.4 | Ch | 4975.6 | 13.7 | Ae |
| | 4947.2 | [12.4 | Ch | 4975.6 | 14.1 | Cd |
| | 4948.2 | [12.3 | Ch | 4976.6 | [13.7 | Bi |
| | 4961.6 | [13 7 | Lv | 4977.7 | [13.5 | B |
| | 4962.3 | 14.1 | L | 4978.6 | 12.6 | Ie |
| | 4963.6 | [13.3 | Ae | 4981.6 | [11.7 | Wa |
| | 4964.7 | 13.9 | Rh | 4981.6 | [12.3 | Ie |
| | 4965.7 | 14.0 | B | 4982.6 | 13 0 | B |
| | 4966.6 | 13.9 | Lv | 4989.6 | [12.4 | Pt |
| 213843 SS Cygni— | | | | | | |
| | 4944.3 | 9.5 | L | 4981.8 | 8.7 | Ae |
| | 4952.5 | 11.7 | Ch | 4981 9 | 8.7 | Pt |
| | 4953.4 | 11.7 | ( | 4982.9 | 8.6 | Pt |
| | 4959.6 | 11.6 | L | 4982.9 | 8.6 | Ae |
| | 4977.9 | 11.7 | Pt | 4985.8 | 8.6 | Ae |
| | 4979.8 | 8 8 | [illegible] | | | |

VARIABLE S9AR OBSERVATIONS RECEIVED DURING APRIL, 1927.

Feb. 0 = J D.2424912; Mar. 0 = J.D. 2424940; Apr. 0 = J.D. 2424971.

| J.D.Est.Obs. | J.D.Est.Obs. | J.D.Est.Obs. | J.D.Est.Obs. | J.D.Est.Obs. | J.D.Est.Obs. |
|---|---|---|---|---|---|
| V SCL | RR AND | R ARI | W PER | W TAU | R PIC |
| *000339* | 004533 | 021024 | 024356 | 042215 | *044349* |
| 915 12.1 Bl | 915 15.5 Bg | 934 10.9 Wk | 962 9.2 Pt | 964 10.7 B | 915 8.0 Bl |
| 927 10.5 Bl | 920[14.8 Bf | 937 11.4 Ch | 969 9.3 B | 974 10.8 Sg | 928 7.2 Bl |
| 938 10.4 Bl | 930 14.6 Bg | 944 12.1 Ht | 969 9.0 Cl | 989 10.0 Wo | 939 6.7 Bl |
| S SCL | 933 14.4 Bg | 944 12.1 L | 980 9.9 Eb | S TAU | V TAU |
| *001032* | — CAS | 959 12.4 Ht | 980 9.8 Kz | 042309 | 044617 |
| 915 9.4 Bl | 004746b | 959 12.4 L | R HOR | 915[14.8 Bg | 936 9.8 Ch |
| 915 9.0 En | 962 10.4 Pt | 962 12.4 Pt | *025050* | 917 15.6 Bg | 952 9.8 Ch |
| 919 9.5 En | W CAS | W AND | 915 6.9 Bl | 930[14.8 Bg | 962 10.5 Pt |
| 919 9.1 Sm | 004958 | 021143a | 915 7.1 En | 965[13.8 B | 964 11.0 B |
| 927 9.4 Bl | 942 12.1 Gg | 937 8.1 Ch | 918 7.1 En | T CAM | 964 10.5 Rh |
| X AND | 962 11.8 Pt | 947 8.3 Ch | 919 6.6 Ht | 043065 | 981 12.7 Ie |
| 001046 | U TUC | 962 8.2 Pt | 921 7.1 Sm | 944 13.7 L | R ORI |
| 915 14.2 Bg | *005475* | T PER | 926 7.1 Ht | 957 12.1 GC | 045307 |
| 920 14.4 Bf | 915 11.8 Bl | 021258 | 927 7.8 Bl | 960 11.8 L | 964 12.6 B |
| 968 13.8 Rh | 915 11.8 En | 941 8.8 Ch | 929 7.3 Ht | 962 11.9 Pt | R LEP |
| T AND | 919 12.0 En | 962 8.7 Pt | 931 7.4 En | RX TAU | *045514* |
| 001726 | 919 11.9 Sm | Z CEP | 933 7.8 Ht | 043208 | 942 9.2 Ch |
| 934 9.9 Wk | 927 12.8 Bl | 021281 | 938 8.2 Bl | 961 11.8 Lv | 950 7.9 L |
| 937 9.5 Ch | 933[11.8 En | 968 14.0 Rh | 940 7.9 Ht | 962 11.9 Pt | 960 7.7 L |
| 939 9.5 Wk | 940 13.2 Sm | o CET | 940 7.6 Sm | 964 12.0 Rh | 960 9.2 Ch |
| 943 9.0 Ch | U SCL | *021403* | T HOR | 964 11.7 B | 962 7.7 Pt |
| T CAS | *010630* | 914 7.1 En | *025751* | R RET | 962 7.5 Jo |
| 001755 | 932[13.2 Bl | 918 7.1 En | 932 12.4 Bl | *043263* | 972 8.4 B |
| 944 10.7 Wk | U AND | 932 7.1 En | U ARI | 915 9.8 Bl | V ORI |
| 947 9.2 Ch | 010940 | 937 7.2 Ch | 030514 | 915 10.5 En | 050003 |
| 950 8.9 L | 968 9.7 Rh | 943 7.5 Ch | 915 14.7 Bg | 918 10.1 En | 941 9.1 Ch |
| 957 8.5 L | S CAS | 944 6.9 L | 931 14.1 Bg | 919 10.1 Ht | 952 9.3 Ch |
| 962 8.9 Jo | 011272 | 949 7.3 Ch | 934 14.0 Bg | 921 10.7 Sm | 958 9.1 B |
| 962 8.4 Pt | 962 10.6 Pt | 950 7.2 L | 936 14.1 Bf | 928 9.5 Bl | 962 9.4 Pt |
| 970 9.2 Wk | 968 11.3 Rh | 957 7.5 L | X CET | 929 9.7 Ht | 964 9.1 Rh |
| 971 9.0 Ya | 971 11.0 Ya | S PER | *031401* | 933 9.7 Ht | 969 9.3 B |
| S TUC | 980 10.9 Eb | 021558 | 944 11.6 L | X CAM | 978 9.6 B |
| *001862* | 980 10.5 Kz | 941 8.7 Ch | 957 12.1 L | 043274 | 981 10.1 Ie |
| 919[12.5 Sm | R PSC | 952 9.1 Ch | 962 12.6 Pt | 942 9.0 Ch | T LEP |
| 931[13.2 Bl | 012502 | 962 8.7 Pt | Y PER | 944 8.2 Gg | *050022* |
| 940[12.4 Sm | 915 8.1 Bg | 969 8.2 B | 032043 | 944 9.1 Gg | 915 8.7 Bl |
| T PHE | 931 8.2 Bg | R FOR | 941 9.9 Ch | 962 7.6 Ch | 928 9.0 Bl |
| *002546* | 934 8.3 Bg | *022426* | 962 9.0 Pt | 962 7.5 Pt | 939 9.6 Bl |
| 916[12.2 Sm | 943 8.3 Ch | 915 8.7 Bl | 969 9.7 B | 969 7.8 B | 962 10.6 Pt |
| 931[13.6 Bl | RU AND | 927 8 8 Bl | 980 9.1 Eb | R DOR | 972 10.8 B |
| W SCL | 013238 | 938 10.5 Bl | 980 8.7 Kz | *043562* | S PIC |
| *002833* | 937 11.2 Ch | U CET | R PER | 915 5.5 Bl | *050848* |
| 932 12.9 Bl | 944 10.9 Ch | *022812* | 032335 | 915 5.8 En | 915 12.6 En |
| U CAS | 960 10.5 Ch | 942 11.0 Ch | 962 9.1 Pt | 918 5.6 En | 932[13.4 Bl |
| 004047 | 962 10.4 Pt | RR CEP | 964 9.3 Rh | 919 5.7 Ht | 940[12.9 Bl |
| 962 8.0 Ch | Y AND | 022980 | 969 9.2 B | 921 5.5 Sm | R AUR |
| 968 8.4 Rh | 013338 | 960 14.0 L | R TAU | 928 5.4 Bl | 050953 |
| V AND | 960 11.2 Ch | 968 14.7 Rh | 042209 | 929 5.6 Ht | 962 12.5 Pt |
| 004435 | 962 11 0 Pt | R TRI | 915 10.3 Bg | 933 5.5 Ht | 966 12.7 Lv |
| 915 12.3 Bg | X CAS | 023133 | 917 10.1 Bg | 938 5.6 Bl | 968 12.3 Cb |
| 920 12.4 Bf | 014958 | 937 7.0 Ch | 930 10.4 Bg | 940 5.5 Ht | 972 12.9 B |
| 930 11.4 Bg | 962 10.5 Pt | 944 7.0 Ch | 934 10.6 Bg | 940 5.5 Sm | 976 13.1 Bi |
| 933 11.3 Bg | 967 10.7 Bn | 952 7.3 Ch | 946 11.0 Ch | R CAE | T PIC |
| X SCL | 972 10.7 Bn | 962 7.5 Pt | 962 12.3 Pt | *043738* | *051247* |
| *004435* | 978 10.9 Bn | 962 7.8 Jo | 965 11.8 B | 919[13.1 Ht | 915 12.6 En |
| 915 11.4 Bl | U PER | 980 8.6 Eb | W TAU | 932 11.9 Bl | 919[13.1 Ht |
| 927 11.2 Bl | 015254 | 980 9.8 Kz | 042215 | 939 11.8 Bl | 933[13.1 Ht |
| 938 11.3 Bl | 962 9.0 Pt | W PER | 960 10.4 Sg | 940 11.5 Sm | 940[13.4 Ht |
| | 969 8.9 B | 024356 | 962 10.1 Pt | | |
| | | 941 9.3 Ch | 962 10.7 Jo | | |

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1927—Continued.

| J.D. | Est. | Obs. |
|---|---|---|
| **T COL** | | |
| *051533* | | |
| 915 | 12.2 | Bl |
| 915 | 12.1 | En |
| 918 | 12.1 | En |
| 919 | 12.1 | Ht |
| 928 | 11.6 | Bl |
| 933 | 11.7 | Ht |
| 939 | 10.9 | Bl |
| 940 | 10.8 | Ht |
| 940 | 11.2 | Sm |
| **S AUR** | | |
| 052034 | | |
| 941 | 10.2 | Ch |
| 950 | 9.3 | L |
| 957 | 9.3 | B |
| 960 | 9.8 | Sg |
| 962 | 9.0 | Pt |
| 969 | 9.1 | Wa |
| 969 | 9.8 | B |
| 969 | 9.1 | L |
| 974 | 9.3 | Sg |
| 975 | 10.1 | B |
| 978 | 9.1 | Wa |
| 978 | 9.5 | Ya |
| 980 | 9.7 | Kz |
| 980 | 10.0 | Eb |
| **W AUR** | | |
| 052036 | | |
| 944 | 13.1 | GC |
| 945 | 13.1 | GC |
| 960 | 14.5 | L |
| 964 | 13.0 | B |
| **S ORI** | | |
| *052404* | | |
| 889 | 10.1 | Wo |
| 962 | 8.6 | Pt |
| 969 | 9.1 | B |
| 971 | 9.0 | Ya |
| 978 | 8.6 | Ya |
| 978 | 9.1 | B |
| **T ORI** | | |
| *053005a* | | |
| 941 | 9.8 | GC |
| 944 | 10.1 | L |
| 950 | 10.1 | L |
| 953 | 10.2 | L |
| 957 | 10.2 | L |
| 958 | 10.3 | B |
| 959 | 10.4 | L |
| 960 | 10.4 | L |
| 961 | 10.2 | B |
| 962 | 10.3 | L |
| 967 | 11.1 | B |
| 968 | 10.8 | GC |
| 968 | 10.4 | Pt |
| 969 | 10.4 | L |
| 969 | 11.1 | B |
| 971 | 11.0 | Ya |
| 975 | 11.1 | B |
| 976 | 10.3 | Pt |
| 977 | 10.3 | Pt |

| J.D. | Est. | Obs. |
|---|---|---|
| **T ORI** | | |
| *053005a* | | |
| 978 | 11.0 | Ie |
| 978 | 10.5 | Ya |
| 981 | 10.4 | Pt |
| 982 | 10.5 | Pt |
| 984 | 10.7 | Pt |
| 989 | 10.1 | Pt |
| **S CAM** | | |
| 053068 | | |
| 934 | 9.4 | Wk |
| 939 | 9.4 | Wk |
| 944 | 8.7 | Wk |
| 962 | 8.3 | Pt |
| 969 | 8.5 | Cl |
| 970 | 8.8 | Wk |
| 978 | 8.5 | Ya |
| **RR TAU** | | |
| 053326 | | |
| 914 | 12.2 | Bg |
| 917 | 12.1 | Bg |
| 918 | 12.2 | Bg |
| 930 | 12.3 | Bg |
| 934 | 12.1 | Bf |
| 936 | 12.1 | Bf |
| 944 | 11.7 | GC |
| 945 | 11.3 | GC |
| 956 | 11.1 | GC |
| 964 | 12.5 | B |
| **RU AUR** | | |
| 053337 | | |
| 960 | 12.1 | Sg |
| 962 | 12.4 | Pt |
| 974 | 12.1 | Sg |
| 980 | 10.5 | Eb |
| **U AUR** | | |
| 053531 | | |
| 889 | 9.9 | Wo |
| 891 | 9.7 | Rt |
| 891 | 9.8 | Wo |
| 942 | 10.5 | Gg |
| 957 | 11.6 | B |
| 962 | 11.6 | Pt |
| 969 | 12.3 | B |
| 975 | 12.6 | B |
| 981 | 12.4 | Ie |
| **SU TAU** | | |
| 054319 | | |
| 935 | 9.8 | Ch |
| 941 | 10.3 | Ch |
| 943 | 10.3 | Ch |
| 944 | 10.6 | L |
| 947 | 10.0 | Ch |
| 951 | 10.0 | Cd |
| 953 | 10.5 | L |
| 955 | 10.0 | Ae |
| 958 | 10.0 | B |
| 961 | 10.1 | B |
| 961 | 10.2 | Lv |
| 961 | 10.3 | Ch |
| 962 | 10.2 | Pt |
| 962 | 10.7 | L |

| J.D. | Est. | Obs. |
|---|---|---|
| **SU TAU** | | |
| 054319 | | |
| 968 | 10.3 | Pt |
| 969 | 9.9 | B |
| 969 | 10.2 | Pt |
| 975 | 10.0 | Cd |
| 975 | 9.9 | B |
| 975 | 10.1 | Ae |
| 976 | 10.2 | Pt |
| 978 | 10.1 | Ie |
| 980 | 10.2 | Eb |
| 980 | 10.3 | Kz |
| 981 | 10.1 | Pt |
| 982 | 10.0 | Pt |
| 989 | 10.1 | Pt |
| **S COL** | | |
| *054331* | | |
| 915 | 9.5 | Bl |
| 915 | 9.7 | En |
| 918 | 9.7 | En |
| 919 | 9.9 | Ht |
| 921 | 9.8 | Sm |
| 928 | 9.5 | Bl |
| 933 | 9.6 | Ht |
| 939 | 9.8 | Bl |
| 940 | 10.1 | Ht |
| 940 | 10.2 | Sm |
| **Z TAU** | | |
| 054615a | | |
| 920 | 14.0 | Bf |
| 934 | 14.1 | Bg |
| **RS TAU** | | |
| 054615b | | |
| 920 | 11.0 | Bf |
| 934 | 10.8 | Bg |
| **R COL** | | |
| *054629* | | |
| 915 | 10.4 | En |
| 915 | 11.0 | Bl |
| 918 | 10.6 | En |
| 919 | 10.4 | Ht |
| 921 | 10.2 | Sm |
| 928 | 10.2 | Bl |
| 933 | 10.2 | Ht |
| 939 | 10.1 | Bl |
| 940 | 10.2 | Ht |
| 940 | 9.9 | Sm |
| **α ORI** | | |
| 054907 | | |
| 957 | 1.2 | L |
| 959 | 1.3 | L |
| 962 | 1.2 | L |
| **U ORI** | | |
| 054920a | | |
| 961 | 11.7 | Lv |
| 962 | 11.6 | Pt |
| 969 | 11.8 | Al |
| 947 | 11.6 | Ch |
| 976 | 11.9 | Bi |
| **UW ORI** | | |
| 054920b | | |
| 961 | 10.7 | Lv |

| J.D. | Est. | Obs. |
|---|---|---|
| **UW ORI** | | |
| 054920b | | |
| 976 | 10.2 | Bi |
| **V CAM** | | |
| 054974 | | |
| 964 | 15.0 | Rh |
| **Z AUR** | | |
| 055353 | | |
| 941 | 10.6 | Ch |
| 962 | 10.5 | Pt |
| 967 | 10.6 | B |
| 968 | 10.8 | Pt |
| 969 | 10.7 | Pt |
| 976 | 10.8 | Pt |
| 977 | 10.8 | Pt |
| 978 | 10.5 | Ya |
| 981 | 10.8 | Pt |
| 982 | 10.7 | Pt |
| 982 | 10.4 | B |
| 984 | 10.7 | Pt |
| 987 | 10.6 | Pt |
| 989 | 10.5 | Pt |
| 990 | 10.5 | Al |
| **R OCT** | | |
| *055686* | | |
| 915 | 11.3 | Bl |
| 921 | 10.9 | Sm |
| 928 | 10.2 | Bl |
| 939 | 10.0 | Bl |
| **X AUR** | | |
| 060450 | | |
| 935 | 9.1 | Ch |
| 941 | 9.2 | Ch |
| 944 | 9.3 | Ch |
| 948 | 10.1 | Ch |
| 957 | 10.5 | B |
| 959 | 10.6 | Ch |
| 962 | 10.7 | Pt |
| 969 | 11.5 | B |
| 981 | 11.8 | Wa |
| 984 | 11.9 | B |
| **ξ GEM** | | |
| 060822 | | |
| 900 | 3.5 | Go |
| 904 | 4.0 | Go |
| 905 | 4.0 | Go |
| 910 | 4.0 | Go |
| 911 | 4.0 | Go |
| 912 | 4.0 | Go |
| 913 | 4.0 | Go |
| 935 | 4.0 | Go |
| **V AUR** | | |
| 061647 | | |
| 967 | 11.7 | B |
| **V MON** | | |
| *061702* | | |
| 943 | 9.3 | Ch |
| 962 | 9.7 | Pt |
| 964 | 10.3 | Rh |
| 981 | 10.4 | Wa |

| J.D. | Est. | Obs. |
|---|---|---|
| **— AUR** | | |
| 062047 | | |
| 913 | 8.7 | L |
| 916 | 8.7 | L |
| 922 | 8.7 | L |
| 924 | 9.3 | L |
| 925 | 9.0 | L |
| 931 | 9.2 | L |
| 932 | 9.0 | L |
| 944 | 10.1 | L |
| 950 | 10.6 | L |
| 953 | 10.3 | L |
| 957 | 10.7 | L |
| 958 | 10.9 | L |
| 959 | 10.8 | L |
| 960 | 10.7 | L |
| 969 | 10.6 | L |
| 974 | 10.6 | L |
| **R MON** | | |
| 063308 | | |
| 962 | 10.8 | Pt |
| 967 | 12.0 | B |
| **NOV PIC** | | |
| *063462* | | |
| 916 | 6.2 | En |
| 919 | 6.3 | En |
| 919 | 6.5 | Ht |
| 919 | 6.3 | Sm |
| 923 | 6.2 | En |
| 927 | 6.2 | En |
| 929 | 6.5 | Ht |
| 933 | 6.4 | Ht |
| 940 | 6.4 | Ht |
| **S LYN** | | |
| 063558 | | |
| 962 | 14.4 | Pt |
| **X GEM** | | |
| 064030 | | |
| 945 | 12.2 | GC |
| 947 | 12.4 | GC |
| 956 | 11.7 | GC |
| 967 | 10.5 | B |
| 970 | 10.7 | Bn |
| 978 | 10.2 | Bn |
| 980 | 9.8 | B |
| **W MON** | | |
| *064707* | | |
| 962 | 10.3 | Pt |
| 972 | 10.5 | B |
| **Y MON** | | |
| 065111 | | |
| 943 | 9.0 | Ch |
| 961 | 9.1 | Lv |
| 962 | 9.3 | Pt |
| 968 | 9.5 | B |
| 976 | 9.8 | Bi |
| 981 | 10.4 | Wa |
| 982 | 10.6 | B |
| 988 | 10.6 | Ya |
| **X MON** | | |
| *065208* | | |
| 943 | 8.4 | Ch |

| J.D. | Est. | Obs. |
|---|---|---|
| **X MON** | | |
| *065208* | | |
| 944 | 8.4 | L |
| 957 | 8.0 | L |
| 968 | 9.1 | Cb |
| 968 | 8.4 | Cb |
| 970 | 8.4 | Cb |
| 975 | 8.3 | Cd |
| **R LYN** | | |
| 065355 | | |
| 957 | 12.5 | GC |
| 962 | 12.6 | Ie |
| 972 | 10.1 | B |
| **V CMI** | | |
| 070109 | | |
| 964 | 14.6 | Rh |
| **R GEM** | | |
| 070122a | | |
| 948 | 9.3 | Ch |
| 961 | 9.8 | Lv |
| 962 | 9.8 | Pt |
| 968 | 9.1 | Cb |
| 968 | 9.6 | B |
| 976 | 9.7 | Bi |
| 977 | 9.9 | Al |
| 984 | 10.0 | B |
| 989 | 10.3 | Al |
| **Z GEM** | | |
| 070122b | | |
| 962 | 12.4 | Pt |
| 968 | 12.4 | B |
| **TW GEM** | | |
| 070122c | | |
| 961 | 8.4 | Lv |
| 962 | 7.8 | Pt |
| 968 | 8.3 | B |
| 984 | 8.3 | B |
| **R CMI** | | |
| 070310 | | |
| 944 | 10.4 | L |
| 957 | 10.6 | L |
| 968 | 10.4 | B |
| 981 | 10.3 | Wa |
| 984 | 10.7 | B |
| **R VOL** | | |
| *070772* | | |
| 915 | 12.6 | En |
| 919 | 12.6 | En |
| 919 | 12.2 | Ht |
| 921 | 11.1 | Sm |
| 933 | 12.2 | Ht |
| 940 | 12.2 | Ht |
| 940 | 11.3 | Sm |
| **RR MON** | | |
| 071201 | | |
| 943 | 11.4 | Ch |
| 961 | 12.1 | Lv |
| 976 | 12.8 | Bi |
| **V GEM** | | |
| 071713 | | |
| 949 | 13.5 | GC |
| 962 | 13.5 | Pt |

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1927—Continued.

J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs.

V GEM
071713
965 13.8 B
967 13.1 GC
S CMI
072708
885 7.5 Rt
888 7.5 Rt
889 7.5 Wo
937 8.0 Ch
940 8.3 Rt
943 8.4 Ch
944 8.2 L
948 8.5 Rt
951 8.7 Cd
957 8.3 L
958 9.0 B
959 9.4 Ch
962 8.8 Jo
962 9.6 Rt
962 9.3 Pt
969 9.6 Wa
973 9.0 Jo
977 9.7 Al
978 9.8 Wa
979 9.3 Jo
980 9.8 B
981 9.8 Wa
984 9.8 Al
984 10.1 Cd
990 9.1 Jo
T CMI
072811
967 10.4 B
980 10.1 B
S VOL
*073173*
915 11.7 Bl
928 11.1 Bl
939 10.9 Bl
U CMI
073508
944 10.2 L
957 9.4 L
962 9.2 Pt
968 9.6 B
S GEM
073723
949 13.6 GC
962 13.6 Pt
965 13.9 B
W PUP
*074241*
915 12.0 Bl
918 12.2 En
919 11.9 Ht
919 11.9 Sm
928 10.9 Bl
929 11.2 Ht
933 10.5 Ht
939 9.6 Bl
940 9.4 Sm

W PUP
*074241*
940 9.4 Ht
T GEM
074323
941 11.7 Ch
962 13.2 Pt
965 13.3 B
967 13.1 GC
U PUP
*075612*
964 12.4 Rh
967 12.1 B
R CNC
081112
944 8.7 L
957 7.8 L
958 7.9 B
960 7.8 Ch
962 7.4 Pt
969 7.0 B
969 7.0 Wa
971 7.6 Ya
978 7.2 Wa
981 7.1 Wa
984 6.8 B
V CNC
081617
943 9.2 Ch
960 8.2 Ch
962 8.0 Pt
981 7.9 Wa
RT HYA
*082405*
962 7.8 Pt
R CHA
*082476*
915 12.7 Bl
919[12.4 Sm
928 12.5 Bl
933[12.4 En
939 12.0 En
939 12.1 Bl
940 11.8 Sm
U CNC
083019
964 14.1 Rh
976[13.0 Lv
X UMA
083350
976 11.7 Lv
S HYA
084803
943 9.5 Ch
960 8.0 Ch
962 8.7 Pt
971 9.1 Ya
971 7.9 Lg
973 7.9 Lg
974 7.9 Lg
981 7.5 Wa

T HYA
*085008*
943 8.2 Ch
944 8.0 L
957 8.2 L
960 8.6 Ch
962 8.3 Pt
962 8.3 Ie
968 8.6 Rh
971 8.7 Ya
T CNC
085120
943 9.2 Ch
960 9.3 Ch
962 8.3 Pt
978 9.3 Ya
T PYX
*090031*
932 [u Bl
W CNC
090425
950 10.6 L
968 10.0 Rh
977 9.5 Al
978 9.0 Wa
981 8.8 Wa
982 8.8 Wa
984 8.7 Wa
989 9.5 Al
RS CNC
090431
904 5.8 Go
905 5.8 Go
906 5.8 Go
908 5.8 Go
910 6.4 Go
911 6.5 Go
912 6.5 Go
930 6.7 Go
935 6.7 Go
943 6.5 Go
944 6.3 Go
946 6.4 Go
947 6.3 Go
RW CAR
*091868*
915 9.9 Bl
916 9.7 En
919 9.7 En
928 10.4 Bl
939 11.1 Bl
Y VEL
*092551*
915 11.3 Bl
916 11.0 En
919 11.3 Sm
928 11.1 Bl
939 11.7 Bl
940 12.4 Sm
R CAR
*092962*
915 9.1 Bl

R CAR
*092962*
916 9.5 En
916 9.2 Sm
919 9.5 En
919 9.2 Ht
921 8.2 Sm
928 8.7 Bl
929 8.9 Ht
931 8.5 En
933 8.5 Ht
939 8.2 Bl
940 8.2 Ht
940 7.9 Sm
X HYA
*093014*
917 10.6 Bf
931 11.2 Bg
942 11.6 Ch
962 12.1 Pt
972 12.9 B
Y DRA
093178
949 8.2 Ch
R LMI
093924
934 10.4 Wk
937 10.5 Ch
939 10.2 Wk
949 10.1 Ch
950 10.2 L
958 9.5 Ch
962 9.5 Ch
962 8.8 Pt
969 8.2 L
970 8.8 Wk
977 7.9 Al
984 7.0 Al
R LEO
094211
889 6.0 Wo
904 6.3 Go
905 6.4 Go
907 6.4 Go
908 6.5 Go
910 6.4 Go
912 6.5 Go
930 6.4 Go
935 6.8 Go
937 6.3 Ch
941 8.0 Go
947 8.0 Go
947 6.6 Ch
948 7.3 Rt
958 7.0 Ch
960 7.0 Sg
962 6.6 Pt
962 7.3 Jo
962 7.1 Rt
963 7.3 Al
968 7.8 B
968 7.2 Cb

R LEO
094211
969 7.0 Wa
973 7.5 Jo
976 8.3 Cb
977 7.5 Al
978 7.2 Rt
978 7.3 Wa
979 7.5 Jo
980 6.8 Eb
980 6.7 Kz
981 7.2 Wa
982 7.1 Wa
984 7.3 Wa
984 7.5 Al
984 7.8 B
985 7.3 Wa
989 7.6 Jo
Y HYA
*094622*
962 6.4 Pt
Z VEL
*094953*
915 12.6 Bl
919 12.5 Ht
919 12.8 Sm
928 12.5 Bl
933 12.8 Ht
939 12.6 Bl
940 12.6 Ht
940 12.3 Sm
V LEO
095421
937 9.3 Ch
947 9.3 Ch
960 10.1 Sg
962 10.1 Pt
968 10.6 Rh
968 10.2 B
976 11.0 Lv
RV CAR
*095563*
932[13.1 Bl
RY LEO
095814
943 9.8 Kl
974 10.1 Kl
975 10.1 Kl
S CAR
*100661*
915 5.5 Bl
915 6.0 En
916 5.8 Sm
919 6.0 En
919 5.5 Ht
921 5.8 Sm
923 5.8 En
928 5.5 Bl
929 5.5 Ht
931 5.7 En
933 5.8 Ht

S CAR
*100661*
939 6.0 Bl
940 6.0 Ht
940 6.0 Sm
Z CAR
*101058*
916[12.3 En
919[12.3 Sm
932[12.6 Bl
940[12.3 Sm
W VEL
*101153*
915 8.9 Bl
919 9.3 Sm
928 9.2 Bl
939 9.5 Bl
940 9.7 Sm
U HYA
*103212*
943 6.5 Go
944 6.5 Go
950 4.9 L
969 5.3 L
R UMA
103769
946 12.3 Ch
961 12.2 Ch
962 11.7 Ie
962 12.0 Pt
965 11.8 B
977 12.0 Al
979 11.1 Cd
W HYA
*104620*
915 9.2 Bl
928 8.5 Bl
939 8.8 Bl
942 9.3 Ch
949 9.2 Ch
950 8.2 L
952 8.8 Ch
960 9.3 Ch
952 8.0 Pt
969 7.8 L
978 8.5 Ya
RS HYA
*104638*
932 13.2 Bl
W LEO
104814
917 14.3 Bf
925 13.7 Bf
934 13.7 Bg
965 13.6 B
968 13.4 Rh
876 13.4 Lv
RS CAR
*110361*
916[12.1 En
919[12.3 Sm
940[12.3 Sm

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1927—Continued.

| J.D.Est.Obs. | J.D.Est.Obs. | J.D.Est.Obs. | J.D.Est.Obs. | J.D.Est.Obs. | J.D.Est.Obs. |
|---|---|---|---|---|---|
| S LEO | SS VIR | RS UMA | U OCT | RT CEN | S BOO |
| 110506 | 122001 | 123459 | *131283* | *134236* | 141954 |
| 947[12.5 Ch | 957 8.2 L | 974 10.6 Sg | 919 9.0 Sm | 928 9.4 Bl | 960 9.2 Sg |
| 952 12.8 GC | 975 9.2 B | 978 10.8 Rt | 919 9.2 Ht | 939 9.1 Bl | 962 9.0 Pt |
| 968 11.8 Rh | T CNV | 979 10.4 Cd | 928 9.1 Bl | R CNV | 969 9.9 L |
| 968 12.7 B | 122532 | 980 10.1 B | 933 9.0 Ht | 134440 | 970 9.6 Wk |
| RY CAR | 937 11.9 Ch | 984 9.8 Rt | 939 9.2 Bl | 934 10.5 Wk | 974 10.4 Sg |
| *111561* | 962 10.3 Pt | 990 8.7 Jo | 940 9.7 Ht | 937 11.5 Ch | 979 10.2 Jo |
| 915 11.2 Bl | 968 10.8 B | S UMA | 940 9.4 Sm | 962 11.0 Pt | 990[11.0 Jo |
| 928 12.0 Bl | 969 10.5 Cl | 123961 | V CNV | 968 11.0 B | RS VIR |
| 939 12.3 Bl | 975 11.0 B | 921 8.5 Kl | 131546 | 975 10.8 B | 142205 |
| RS CEN | 981 10.1 Wa | 934 8.7 Wk | 907 7.0 Go | 981 10.7 Ie | 980 12.1 Rh |
| *111661* | 986 10.8 Cl | 936 8.3 Kl | 910 6.8 Go | RX CEN | V BOO |
| 915 10.6 Bl | Y VIR | 937 8.2 Ch | 911 7.2 Go | *134536* | 142539a |
| 919 11.6 Sm | *122803* | 939 8.7 Wk | 913 7.2 Go | 918[13.1 Bl | 950 7.1 L |
| 928 12.4 Bl | 917 13.6 Bf | 943 8.3 Kl | 914 7.2 Go | 932[13.1 Bl | 957 6.7 L |
| 939 12.9 Bl | 925 13.3 Bf | 944 8.7 Wk | 943 7.1 Go | T APS | 962 7.0 Pt |
| 940 12.1 Sm | 934 13.9 Bf | 944 8.1 Rt | 944 7.2 Go | *134677* | 969 7.0 L |
| X CEN | 971 14.0 Rh | 949 8.5 Wk | 946 7.2 Go | 915 9.3 Bl | 973 7.6 Jo |
| *114441* | 980[13.8 B | 950 7.5 L | 947 7.2 Go | 919 9.0 Sm | 979 7.4 Jo |
| 915 12.5 Bl | U CEN | 952 8.2 Ch | W VIR | 928 9.4 Bl | 989 7.8 Jo |
| 928 12.0 Bl | *122854* | 953 8.3 Kl | *132002* | 939 9.9 Bl | R CAM |
| 939 11.3 Bl | 915 10.4 Bl | 955 7.7 Rt | 947 10.0 B | RR VIR | 142584 |
| W CEN | 928 10.0 Bl | 957 8.2 Kl | V VIR | *135908* | 942 7.2 Ch |
| *115058* | 939 8.9 Bl | 957 7.5 B | *132202* | 962 13.2 Pt | 958 6.9 Ch |
| 932 13.1 Bl | R UMA | 960 8.2 Sg | 936 9.1 Ch | 971 14.1 Rh | R BOO |
| R COM | 123160 | 962 8.1 Pt | 948 9.1 Ch | Z BOO | 143227 |
| 115919 | 921 9.8 Kl | 970 8.6 Cb | 971 8.9 Rh | 140113 | 962 12.3 Pt |
| 968 11.7 B | 934 10.2 Wk | 970 9.0 Wk | 977 8.6 B | 980 14.0 Rh | Y LUP |
| 969 11.5 Cl | 936 10.2 Kl | 973 8.1 Jo | H HYA | RU HYA | *145254* |
| 971 12.1 Rh | 937 10.7 Ch | 977 8.3 Al | *132422* | 140528 | 918[13.7 Bl |
| 975 10.8 Cd | 939 10.3 Wk | 978 8.5 Rt | 915 9.1 Bl | 915 9.2 Bl | 932[12.8 Bl |
| 976 10.7 Lv | 944 10.6 Wk | 979 8.3 Cd | 928 8.8 Bl | 928 9.3 Bl | S APS |
| SU VIR | 947 11.5 Ch | 980 8.6 B | 939 9.2 Bl | 939 10.3 Bl | *145971* |
| 120012 | 961 12.4 Ch | 981 8.3 Wa | 959 9.1 L | R CEN | 915 10.1 Bl |
| 947 12.2 Ch | 962 12.3 Pt | 982 8.3 Wa | 962 8.5 Pt | *140959* | 919 9.9 Sm |
| 962 9.6 Pt | 962 12.3 Ie | 984 8.4 Wa | S VIR | 915 8.2 Bl | 928 10.0 Bl |
| 965 9.8 B | 965 12.5 B | 984 8.5 Rt | *132706* | 919 8.3 Ht | 939 10.0 Bl |
| 978 8.8 Wa | 979 12.4 Cd | 988 8.6 Al | 936 11.0 Ch | 919 7.3 Sm | 940 10.1 Sm |
| 980 9.3 B | 980 12.6 B | 990 8.8 Jo | 962 9.3 Pt | 927 8.2 En | T LIB |
| 981 8.7 Wa | R VIR | RU VIR | 978 8.2 Wa | 928 8.1 Bl | 150519 |
| 982 8.8 Wa | 123307 | 124204 | 974 8.4 Lg | 931 8.1 En | 977 13.5 Pt |
| 984 8.8 Wa | 936 9.5 Ch | 947 13.0 GC | 977 8.2 B | 933 8.6 Ht | S LIB |
| T VIR | 948 8.3 Ch | 951 13.1 GC | 981 8.2 Wa | 939 8.7 Bl | 151520 |
| *120905* | 957 7.7 L | 962 12.7 Pt | RV CEN | 940 9.0 Ht | 949 9.2 Ch |
| 962 9.3 Pt | 962 7.5 Pt | 965 12.2 B | *133155* | U UMI | 959 9.3 L |
| 965 9.6 B | 972 7.5 B | 971 12.7 Rh | 915 7.2 Bl | 141567 | 977 9.9 Pt |
| 971 10.0 Rh | 973 7.9 Bu | 980 12.3 B | 928 7.2 Bl | 936 10.6 Ch | S SER |
| 976 9.8 Lv | 974 7.8 Bu | U VIR | 939 7.5 Bl | 962 11.6 Pt | 151714 |
| 980 9.7 B | 978 7.8 Wa | 124606 | T UMI | 968 11.3 B | 977 13.2 Pt |
| 981 9.0 Wa | 981 7.7 Wa | 962 9.8 Pt | 133273 | 969 11.5 Cl | 987 14.0 Rh |
| R CRV | 990 8.5 Bu | 972 10.7 B | 968 13.5 B | 978 11.8 Wa | S CRB |
| *121418* | RS UMA | 981 11.4 Wa | T CEN | 981 11.7 Wa | 151731 |
| 917 13.2 Bf | 123459 | 982 11.7 Wa | *133633* | 982 11.7 Wa | 936 9.0 Ch |
| 925 13.0 Bf | 917 15.0 Bf | RV VIR | 915 8.7 Bl | 984 12.0 B | 941 9.5 Ch |
| 934 12.3 Bf | 925 14.3 Bf | *130212* | 919 9.0 Ht | S BOO | 964 10.0 Gb |
| 962 10.3 Pt | 934 14.1 Bf | 967[13.6 B | 928 8.2 Bl | 141954 | 973 9.7 Jo |
| 965 10.3 B | 947 12.6 Ch | U OCT | 933 7.7 Ht | 942 8.2 Ch | 974 10.0 Sg |
| 969 9.9 L | 960 12.0 Sg | *131283* | 939 6.6 Bl | 944 8.2 Wk | 977 9.9 Pt |
| 973 10.1 Bu | 961 11.8 Ch | 915 8.7 Bl | RT CEN | 950 8.7 L | 979 9.9 Cd |
| 980 9.1 B | 962 11.6 Pt | | *134236* | 958 9.2 Ch | |
| 990 9.3 Bu | 965 11.6 B | | 915 10.2 Bl | | |

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1927—Continued.

| J.D.Est.Obs. | J.D.Est.Obs. | J.D.Est.Obs. | J.D.Est.Obs. | J.D.Est.Obs. | J.D.Est.Obs. |
|---|---|---|---|---|---|
| RS LIB | R SER | W CRB | RW SCO | W LYR | X LYR |
| *151822* | 154615 | 161138 | *170833* | 181136 | 190926 |
| 918 8.2 Bl | 949 7.6 Ch | 977 12.2 Pt | 918[12.6 Bl | 959 8.0 L | 977 9.0 Pt |
| 959 8.0 L | 977 8.7 Pt | 979 12.5 Cd | Z OPH | 970 7.6 Gb | RU LYR |
| RU LIB | 981 8.5 Wa | V OPH | 171401 | 977 8.0 Pt | 190941 |
| *152714* | V CRB | *162112* | 977 11.1 Pt | 979 8.0 Jo | 977 13.9 Pt |
| 977 13.3 Pt | 154639 | 977 9.1 Pt | RS HER | 989 7.8 Jo | U DRA |
| 981[10.9 Wa | 977 11.2 Pt | U HER | 171623 | RV SGR | 190967 |
| R NOR | RR LIB | 162119 | 977 8.7 Pt | *182133* | 953 10.0 Ch |
| *152849* | *155018* | 977 12.0 Pt | S OCT | 918 11.2 Bl | 977 9.5 Pt |
| 915 7.0 Bl | 949 9.1 Ch | SS HER | *172486* | SV HER | W AQL |
| 928 6.8 Bl | 959 9.3 L | 162807 | 915 9.0 Bl | 182224 | *191007* |
| 939 7.5 Bl | 977 10.1 Pt | 959 10.2 L | 919 8.6 En | 977 13.6 Pt | 953 9.8 Ch |
| X LIB | RZ SCO | 977 11.8 Pt | 919 9.1 Ht | X OPH | 977 10.5 Pt |
| *153020* | *155823* | T OPH | 928 7.8 Bl | 183308 | T SGR |
| 918 12.5 Bl | 977 12.5 Pt | *162815* | 933 7.4 Ht | 959 8.9 L | *191017* |
| W LIB | Z SCO | 918[12.8 Bl | 939 7.1 Bl | 977 8.5 Pt | 977 11.6 Pt |
| *153215* | *160021* | 977 9.3 Pt | 940 7.6 Ht | R SCT | R SGR |
| 918 11.5 Bl | 918 11.3 Bl | S OCT | RU OPH | *184205* | *191019* |
| S UMI | R HER | *162816* | 172809 | 948 5.9 Ch | 977 12.5 Pt |
| 153378 | 160118 | 918[13.1 Bl | 977 13.7 Pt | 959 5.6 L | RY SGR |
| 936 8.9 Ch | 987 14.5 Rh | 977 10.6 Pt | 988 14.1 Rh | 977 5.3 Pt | *191033* |
| 962 9.0 Pt | U SER | W HER | RU SCO | 981 5.5 Pt | 918 9.1 Bl |
| 974 9.5 Sg | 160210 | 163137 | *173543* | 982 5.4 Pt | 933 9.0 Bf |
| U LIB | 977 9.1 Pt | 948 10.3 Ch | 918 11.7 Bl | NOV AQL | 934 8.6 Bf |
| *153620a* | 981 9.2 Wa | 977 12.2 Pt | SV SCO | 184300 | 952 6.4 Ch |
| 918[12.9 Bl | X SCO | 987 12.6 Rh | *174135* | 952 10.6 Ch | 977 6.3 Pt |
| T NOR | *160221a* | R DRA | 918 12.5 Bl | 977 11.3 Pt | 981 6.5 Pt |
| *153654* | 918 11.4 Bl | 163266 | W PAV | 981 11.4 Pt | 982 6.4 Pt |
| 919 8.6 Ht | SX HER | 934 10.5 Wk | *174162* | RX LYR | S SGR |
| 933 7.9 Ht | 160325 | 977 12.5 Pt | 918[13.0 Bl | 185032 | *191319a* |
| Z LIB | 959 7.8 L | RR OPH | RS OPH | 954[13.0 Ch | 977 13.0 Pt |
| *154020* | 962 7.8 Pt | *164319* | *174406* | 977 12.5 Pt | Z SGR |
| 918[12.7 Bl | 968 8.0 Pt | 917 14.4 Bf | 977 11.2 Pt | S CRA | *191321* |
| R CRB | 977 8.0 Pt | 925 14.2 Bf | T DRA | *185437a* | 982[13.2 Ae |
| 154428 | 981 8.0 Pt | 934 14.2 Bf | 175458a | 918 12.0 Bl | SW SGR |
| 936 6.1 Ch | 982 8.1 Pt | 977 11.5 Pt | 982 10.8 Cd | ST SGR | *191331* |
| 953 5.8 Ch | 987 8.0 Pt | S HER | 988 10.9 Rh | *185512a* | 918[12.4 Bl |
| 962 6.0 Ie | W SCO | 164715 | UY DRA | 954[12.5 Ch | TZ CYG |
| 964 6.0 Gb | *160519* | 948 8.5 Ch | 175458b | R CRA | 191350 |
| 967 6.0 Gb | 918[12.5 Bl | 977 8.6 Pt | 982 10.9 Cd | *185537a* | 981 10.5 Pt |
| 968 6.1 Pt | RU HER | RS SCO | 988 11.4 Rh | 918 12.0 Bl | U LYR |
| 969 6.1 L | 160625 | *164844* | RY HER | T CRA | 191637 |
| 973 5.8 Jo | 949 9.3 Ch | 918 7.7 Bl | 175519 | *185537b* | 981 11.6 Pt |
| 974 6.2 Sg | 959 8.9 L | RR SCO | 977 13.0 Pt | 918[12.5 Bl | RT AQL |
| 976 6.1 Pt | 977 9.7 Pt | *165030* | V DRA | RT LYR | 193311 |
| 977 6.1 Pt | 979 9.0 Jo | 918 11.4 Bl | 175654 | 185737 | 948 10.6 Ch |
| 978 6.0 Wa | 981 9.3 Ac | RV HER | 977 9.9 Pt | 952 10.9 Ch | 981 11.5 Pt |
| 979 6.1 Cd | 987 10.1 Rh | 165631 | T HER | V AQL | R CYG |
| 979 6.1 Jo | R SCO | 977 14.6 Pt | 180531 | *185905* | 193449 |
| 981 5.9 Wa | *161122a* | 988[14.5 Rh | 977 10.7 Pt | 953 7.1 Ch | 948 8.0 Ch |
| 981 6.1 Pt | 918[13.0 Bl | RT SCO | W DRA | R AQL | 981 8.6 Pt |
| 982 6.1 Pt | 925 14.6 Bf | *165636* | 180565 | 190108 | RZ AQL |
| 984 6.1 Pt | 934 14.3 Bf | 918 8.9 Bl | 984[12.3 Cd | 952 10.5 Ch | 193509 |
| 984 6.0 Wa | 977 11.7 Pt | R OPH | NOV OPH | 977 10.9 Pt | 981 12.2 Pt |
| 987 6.2 Pt | S SCO | *170215* | 180911 | RW SGR | T PAV |
| 990 6.0 Jo | *161122b* | 948 9.3 Ch | 977[13.0 Pt | *190819a* | *193972* |
| X CRB | 917 10.4 Bf | 977 10.6 Pt | RY OPH | 952 9.7 Ch | 913[12.1 Sm |
| 154536 | 918 11.1 Bl | RT HER | 181103 | 977 9.0 Pt | 931[13.2 Bl |
| 977 12.6 Pt | 925 10.7 Bf | 170627 | 977 13.0 Pt | S LYR | RT CYG |
| | 934 11.8 Bf | 988[14.5 Rh | | 190925 | 194048 |
| | | | | 977 10.5 Pt | 948 10.0 Ch |

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1927—Continued.

| J.D.Est.Obs. | J.D.Est.Obs. | J.D.Est.Obs. | J.D.Est.Obs. | J.D.Est.Obs. | J.D.Est.Obs. |
|---|---|---|---|---|---|
| RT CYG | R TEL | SZ CYG | R VUL | RU CYG | Z AND |
| 194048 | *200747* | 202946 | 205923 | 213753 | 232848 |
| 953 9.7 Ch | 918[12.4 Bl | 981 8.8 Pt | 981 8.8 Pt | 939 8.8 Wk | 968 10.1 Rh |
| 981 7.2 Pt | Z AQL | 982 9.0 Pt | RS AQR | 952 9.0 Ch | ST AND |
| TU CYG | *200906* | 987 9.6 Pt | *210504* | 981 8.5 Pt | 233335 |
| 194348 | 981 10.6 Pt | ST CYG | 981 10.6 Pt | RV CYG | 937 10.6 Ch |
| 981 10.6 Pt | RS CYG | 202954 | R EQU | 213937 | R AQR |
| X AQL | 200938 | 981 13.6 Pt | 210812 | 981 6.6 Pt | *233815* |
| 194604 | 948 8.6 Ch | V VUL | 981 10.0 Pt | RR PEG | 815 8.6 Bf |
| 981 13.5 Pt | 952 8.4 Ch | *203226* | T CEP | 214024 | 818 8.6 Bf |
| χ CYG | 953 7.8 Ch | 981 8.5 Pt | 210868 | 981 9.7 Pt | 822 9.2 Bf |
| 194632 | 959 7.6 L | S DEL | 934 10.5 Wk | R GRU | 826 9.6 Bf |
| 948 5.5 Ch | 970 7.4 Gb | 203816 | 939 10.7 Wk | *214247* | 849 8.4 Bf |
| 959 5.5 L | 981 7.3 Pt | 981 11.7 Pt | 948 10.3 Ch | 931[11.4 Bl | 852 8.9 Bf |
| 981 6.3 Pt | R DEL | V CYG | 960 9.2 L | S GRU | 855 9.0 Bf |
| RU SGR | 201008 | 203847 | 970 9.8 Wk | *221948* | 860 8.8 Bf |
| *195742* | 959 8.3 L | 952 11.0 Ch | 981 8.2 Pt | 919 9.6 En | 864 8.6 Bf |
| 918 8.1 Bl | 981 9.2 Pt | 981 10.0 Pt | RR AQR | 919 10.3 Sm | 871 8.5 Bf |
| NOV CYG | SX CYG | T DEL | *210903* | R IND | 877 8.6 Bf |
| 195553 | 201130 | 204016 | 981 10.2 Pt | *222867* | 882 8.5 Bf |
| 977[12.2 Pt | 981 13.8 Pt | 981 11.9 Pt | X PEG | 915 8.8 Bl | 888 8.7 Bf |
| 981[12.2 Pt | WX CYG | V AQR | 211614 | 927 9.1 Bl | 902 8.7 Bf |
| Z CYG | 201437b | 204102 | 981 9.6 Pt | 938 9.2 Bl | 905 9.3 Bf |
| 195849 | 948 10.6 Ch | 981 8.2 Pt | W CYG | T TUC | 912 9.3 Bf |
| 981 11.7 Pt | 970 11.0 Gb | T AQR | 213244 | *223462* | 919 8.6 Bf |
| SY AQL | 981 11.0 Pt | *204405* | 903 6.1 Go | 919 8.3 Sm | 930 8.6 Bf |
| 200212 | U CYG | 981 7.2 Pt | 906 5.3 Go | 944 10.9 L | RR CAS |
| 959 12.6 L | 201647 | RZ CYG | 910 5.3 Go | RW PEG | 235053 |
| 981 12.0 Pt | 952 7.8 Ch | 204846 | 913 5.3 Go | 225914 | 967 11.6 Bn |
| S AQL | 970 7.8 Gb | 981 12.8 Pt | S CEP | 915 13.0 Bg | 978[11.4 Bn |
| 200715a | 981 7.8 Pt | S IND | 213678 | V PHE | R TUC |
| 953 9.3 Ch | Z DEL | *204954* | 889 9.3 Wo | *232746* | *235265* |
| 981 9.8 Pt | 202817 | 931[11.7 Bl | 981 9.0 Pt | 915 10.0 En | 915 12.8 En |
| RW AQL | 981 8.5 Pt | X DEL | RU CYG | 916 9.7 Sm | 919 12.8 En |
| 200715b | SZ CYG | 205017 | 213753 | 919 10.1 En | 919 12.9 Sm |
| 981 9.3 Pt | 202946 | 981 10.0 Pt | 934 9.0 Wk | 921 10.0 Sm | 940[12.9 Sm |
| | 977 8.9 Pt | | | | |

Total observations, 1409; Total variables, 334; Total observers, 36.

Bhaskaran, "Bg"; Bouton, "B"; Brown, "Bn"; Bush, "Bu"; Cherrington, "Cb"; Clement, "Cl"; Chandra, "Ch"; Chandler, "Cd"; Ebert, "Eb"; Ensor, "En"; Gaebler, "Gb"; Georgetown College, "GC"; Messrs. Gomi, "Go"; Greenberg, "Gg"; Houghton, "Ht"; Iedema, "Ie"; Jones. "Jo"; Kohl, "Kl"; Kurtz, "Kz"; Lacchini, "L"; Leavenworth, "Lv"; Logan, "Lg"; Peltier, "Pt"; Recht, "Rh"; Rittenberg, "Rt"; Skaggs, "Sg"; Smith, "Sm"; Watkins, "Wk"; Watson, "Wa"; Wolff, "Wo"; and Yalden, "Ya".

LEON CAMPBELL, Recording Secretary.

May 9, 1927.

## METEOR NOTES.

### By CHARLES P. OLIVIER.

Mr. R. M. Dole of the Weather Bureau Office at East Lansing, Mich., seems to have been the only one of our observers who had good luck (and has reported) on the April Lyrids and May Aquarids. On April 19, 21, and 22 he observed 6, 16,

and 46 meteors respectively, both the main Lyrid and adjacent radiants in Hercules being strongly represented. Most of the Lyrids were faint, but there were five really brilliant ones.

Mr. John Koep of Chippewa Falls, Wis., was ready to observe on five nights but only April 19 was clear. On this night he saw 5 meteors, none being from Lyra, and he states further that each was from a separate radiant.

C. P. Olivier at University, Va., had partly clear skies on April 23 and 24. The Lyrid shower was evidently not active but 8 and 4 meteors respectively were seen on the two nights. On the first, observations continued for 1½ hours, but clouds were continually passing; on the second, observations continued for 66 minutes in a clear sky. One meteor only on each night was a possible Lyrid.

At University, Va., the second halves of all the nights of the first week in May were cloudy, and so observations on the Aquarids unfortunately were impossible. Mr. R. M. Dole, however, was favored with clear skies on May 1, 4, 5, and 6, and reports a very active shower of Aquarids. The numbers of all meteors, mostly Aquarids, were respectively 13, 34, 42, and 38 on the above dates. That this many Aquarids could be seen from a station so far north shows that for one observing nearer to or south of the equator this should be one of the most prominent annual showers. As these meteors are known to be connected with the famous Halley's Comet, it is a great pity more observers do not concentrate efforts upon them. It is also one of the cases for which a moving radiant has been detected by competent observers. The meteors frequently leave trains and are in other respects individually interesting.

Mr. R. A. McIntosh of Auckland, N. Z., our most regular observer in the Southern Hemisphere, on March 6 from $1^h$ to $2\frac{1}{2}^h$ N.Z.C.T. observed in a clear sky and saw 17 meteors. One excellent radiant at $\alpha = 175°$, $\delta = -56°$ is shown on his map, and another less certain one at $\alpha = 228°$, $\delta = -63°$. We cannot lay too much emphasis on the importance of meteor observations from the Southern Hemisphere.

Information is still coming in about the great fireball seen in North Carolina on February 27, so while some preliminary work has been done, and the point above which it burst approximately fixed, further information is being awaited before final reduction and publication.

Bulletin No. 9 of the American Meteor Society is now being prepared. This will contain a list of members with their addresses and a general statement of the aims and needs of the Society.

Leander McCormick Observatory, University of Virginia,
1927 May 21.

## COMET NOTES.

**By G. VAN BIESBROECK.**

During the month of May the four comets at present under observation have been followed here as far as the unfavorable weather has allowed.

In the western sky Comet 1926 *f* (Comas Solá) is slowly losing in brightness. Hardly brighter than $14^M$ on May 19 it will gradually be overtaken by the daylight, which will before long set an end to the visibility. There is, however, a good chance that it will be observed further next winter, at least with the larger instruments. This will give a well determined orbit and make it possible to establish the exact periodicity and also to verify the suspected identity with Comet 1890 VII (Spitaler).

COMET 1927 *e* (GRIGG-SKJELLERUP) has brightened up appreciably since last month and starts now on its rapid geocentric course through the northern sky. On May 20 it was seen here as a large round nebulosity fully 10′ in diameter. The total brightness was estimated as equivalent to a star of magnitude 9 in the 4-inch finder. But the central part of the coma is not very bright and the nucleus quite indistinct, so that accurate measurement is difficult. Last month's ephemeris (p. 283), which represents the comet's course quite closely, has been extended by the writer so as to cover also the month of July.

EPHEMERIS OF COMET GRIGG-SKJELLERUP.

| 1927 $0^h$ U.T. | | $\alpha$ h m | $\delta$ ° ′ | Log. $r$ | Log. $\Delta$ | Mag. |
|---|---|---|---|---|---|---|
| June | 3 | 10 24.1 | +58 30 | 9.983 | 9.308 | 11.3 |
| | 7 | 11 50.6 | 63 18 | | | |
| | 11 | 13 27.4 | 64 7 | 0.005 | 9.336 | 11.5 |
| | 15 | 14 47.6 | 61 33 | | | |
| | 19 | 15 42.9 | 57 33 | 0.029 | 9.403 | 12.0 |
| | 23 | 16 19.6 | 52 48 | | | |
| | 27 | 16 45.1 | 48 23 | 0.055 | 9.482 | 12.3 |
| July | 1 | 17 3.3 | 44 17 | | | |
| | 5 | 17.4 | 40 30 | 0.081 | 9.559 | 12.5 |
| | 9 | 28.0 | 37 1 | | | |
| | 13 | 36.9 | 33 49 | 0.107 | 9.633 | 12.7 |
| | 17 | 44.6 | 30 15 | | | |
| | 21 | 51.2 | 28 6 | 0.132 | 9.702 | 12.9 |
| | 25 | 17 57.3 | 25 31 | | | |
| | 29 | 18 2.9 | 23 7 | 0.156 | 9.766 | 13.1 |
| Aug. | 2 | 18 8.3 | +20 51 | | | |

The magnitudes given in the last column represent the theoretical brightness of the nucleus. The total light impression was two or three magnitudes brighter in the middle of May. Toward the end of June the comet leaves the constellation of Draco and enters Hercules, where it will stay until the middle of August.

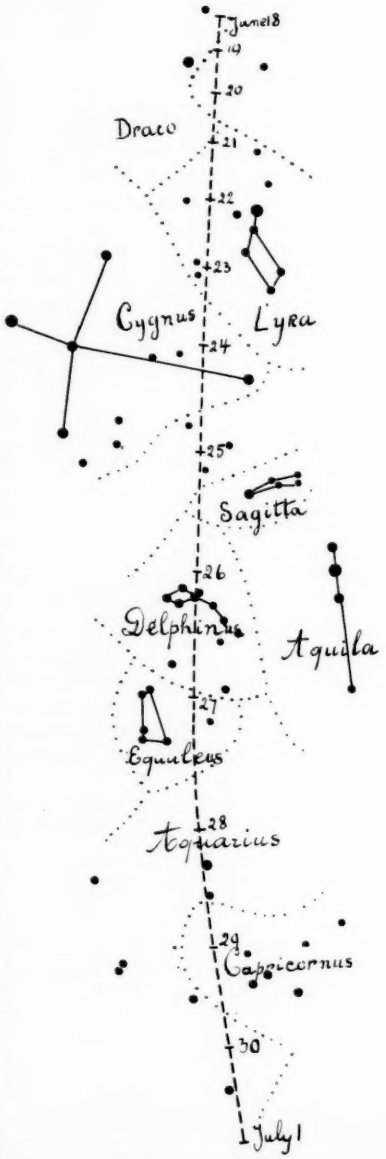
COMET 1927 *d* (STEARNS), which comes next in order of right ascension, is still visible under excellent conditions. It has followed its predicted path with little change in brightness or in appearance. On May 16 the ephemeris based on Thiele's elements (p. 285) required a correction of less than a minute of arc. The following ephemeris which I computed from the same orbit will enable observers to keep track of this very distant comet through the summer months, during which it slowly moves northward in the constellation of Boötes.

EPHEMERIS OF COMET STEARNS.

| 1927 $0^h$ U.T. | | $\alpha$ h m s | $\delta$ ° ′ | Log. $\Delta$ | Log. $r$ | Mag. |
|---|---|---|---|---|---|---|
| May | 31 | 14 13 31 | +19 32.3 | 0.482 | 0.573 | 10.2 |
| June | 8 | 8 18 | 20 57.0 | .497 | .574 | .3 |
| | 16 | 4 14 | 22 4.0 | .514 | .575 | .3 |
| | 24 | 14 1 21 | 22 55.5 | .531 | .577 | .4 |
| July | 2 | 13 59 40 | 23 33.5 | .547 | .579 | .5 |
| | 10 | 59 10 | 24 0.4 | .563 | .581 | .6 |
| | 18 | 13 59 47 | 18.6 | .579 | .584 | .7 |
| | 28 | 14 1 26 | 30.0 | .594 | .586 | .8 |
| Aug. | 3 | 4 1 | 36.3 | .607 | .588 | 10.9 |
| | 11 | 7 29 | 38.8 | .620 | .591 | 11.0 |
| | 19 | 11 44 | 39.3 | .632 | .593 | .0 |
| | 27 | 16 43 | 38.6 | .642 | .596 | .1 |
| Sept. | 4 | 22 20 | 37.8 | .652 | .599 | .2 |
| | 12 | 28 31 | 37.9 | .660 | .602 | .2 |
| | 20 | 35 14 | 39.7 | .667 | .605 | .3 |
| | 28 | 14 42 26 | +24 44.1 | 0.673 | 0.608 | 11.3 |

Mr. N. Bobrovnikoff found the object too faint for photographing the spectrum here with the usual equipment. But on examining the comet on May 6 through a direct vision spectroscope attached to the 40-inch telescope he and the writer saw the three brightest bands of the Swan-spectrum distinctly standing out from the continuous background, which is quite remarkable for an object situated at 3.7 astronomical units from the sun.

PERIODIC COMET PONS-WINNECKE (1927 *c*) is now rapidly approaching the earth and brightening up accordingly. On May 20 it showed in the 4-inch finder as a round nebulosity 9′ in diameter, with a well defined 11$^{M}$ nucleus. The total brightness was estimated as of magnitude 9 by comparison with the extra-focal images of neighboring stars. The inner coma was brightest in the second quadrant suggesting a broad streamer emitted by the nucleus in that direction but there was no indication of a tail. The ephemeris given last month (p. 284) makes it easy to pick up the comet from now on even in a small telescope. The diagram will be useful in locating the region on the corresponding dates. In the middle of May the correction of the ephemeris was +45$^{s}$ in right ascension and +4′ in declination. The dates given are for the beginning of the day in Universal Time; *e.g.*, June 27 means June 27.0 U.T. = June 26 at 6 P.M. C.S.T. The brightness increases theoretically by four magnitudes between May 20 and the end of June. Therefore, the comet will almost certainly come in reach of the unaided eye at the time of its closest approach. Unless the actual size of the coma diminishes considerably as it nears perihelion the apparent diameter would then be more than a degree. Since the distance to the earth becomes ten times smaller than




PATH OF PONS-WINNECKE COMET FROM JUNE 18 TO JULY 1, 1927.

it was on May 20, when the apparent diameter was estimated as 9'.

The next expected periodic comet is a faint object found in 1911 at Nice (France) by Schaumasse. Its period of about 8 years brought it back in 1919 when it was recovered by the same observer but followed only for two months. In the March number of the *Journal of the British Astr. Assoc.* (p. 240) Crommelin gives a search ephemeris for the present return or third apparition. The ephemeris starts already in July but the position is then too close to the sun and it is only in October that the conditions become somewhat more favorable. The closest approach to the sun is expected about October 1; the distance to the earth is smallest about the same time but the minimum is nearly two astronomical units and the comet will be quite faint.

Williams Bay, Wisconsin, May 21, 1927.

## GENERAL NOTES.

**Announcement.** — Our readers, especially those concerned with the teaching of astronomy, will be interested to know that in the fall numbers of POPULAR ASTRONOMY we are planning to publish a series of papers bearing on the teaching of astronomy in colleges and universities. This series is being contributed by men who have had exceptional success in this line of work.

**Dr. Harlow Shapley,** director of the Harvard College Observatory, gave a lecture entitled "Beyond the Milky Way" at Cornell University on March 12. (*Science,* April 22, 1927.)

**Professor Jens Fredrik Schroeter,** head of the Observatory at Oslo and the author of various works on astronomy, died on April 28, aged seventy years. (*Science,* May 20, 1927.)

**Professor Harlan True Stetson,** in charge of the Astronomical Laboratory of Harvard University, is one of the thirty-five persons recently admitted as Fellows of the American Academy of Arts and Sciences.

**Professor S. A. Mitchell,** director of the McCormick-Chaloner eclipse expedition to Norway, sailed on the *SS Frederick the Eighth* on May 11. Professor Harlan T. Stetson of Harvard University and Professor Frederick Slocum of the Van Vleck Observatory will sail later to take part in the eclipse observations.

**Dr. George Ellery Hale,** honorary director of the Mt. Wilson Observatory, was awarded the Franklin Medal and certificate of honorary membership, at the meeting of the Franklin Institute in Philadelphia on May 18. Following the award a paper by Dr. Hale entitled "The Sun as a Research Laboratory" was presented by Professor Harlow Shapley.

**American Astronomical Society.** —The next meeting of the Society will be held at the University of Wisconsin, Madison, September 6 to 9, 1927. The American Mathematical Society and the Mathematical Association of America will also be holding sessions at Madison during the same week.

**Astronomical Observatory Bequest Upheld.**—On April 19, 1927, the Sixth Court of Civil Appeals, sitting at Texarkana, Texas, affirmed the decision of the Lamar County District Court, which last September sustained the will of the late W. J. McDonald, who died on February 7, 1926, bequeathing over a million dollars to establish an astronomical observatory in connection with the University of Texas.

**Charles A. Young Professorship.**—Princeton University has established a professorship in memory of Charles A. Young, who was professor of astronomy at the university from 1887 to 1908. Professor Henry Norris Russell, director of the Princeton Observatory, has been made the first incumbent. (*Science*, April 29, 1927.)

**A Bright Meteor.**—While on the main road from Danbury to Bridgeport on April 20, 1927, between 9 and 9:15 P.M., Eastern Standard Time, at a point whose approximate coordinates are latitude 41° 16′ N, longitude 73° 20′ W, my attention was attracted by three or four bright flashes which lit up the landscape in front of me. Looking back, I saw a large meteor apparently drop from the zenith. The light was intense enough to illuminate the surrounding country, and its color like that of a Cooper-Hewitt lamp. It left a trail of reddish particles and disappeared about twelve or fifteen degrees above the horizon in a direction approximately sixty degrees west of the north point.

WALTER E. INGLIS.

No. 2 Marne Ave., Bridgeport, Conn. Stratfield.

**Reductions of Occultations,** recently observed at Leonia, N. J., Lat. 40° 51′ 50″ N, Long. 73° 59′ 19″ W.

Formulas for reductions after R. T. A. Innes, *Ast. Jour.*, No. 835, modified by the Yale University Observatory.

IMMERSIONS.

| No. | Star | $\alpha' = $ R.A. | $\delta' = $ Dec. | Date | G.C.T. | $\chi - \rho$ | $\sigma' - \sigma$ | Seeing |
|---|---|---|---|---|---|---|---|---|
| | | h m s | ° ′ ″ | | h m s | ° ′ | ″ | |
| 1 | 290 B. Agr | 23 10 50.68 | −11 5 17.2 | Dec. 11, 1926 | 22 17 33.0 | −68 12 | +0.6 | Good |
| 2 | 24 B. Cet | 0 6 33.62 | − 5 39 22.4 | Dec. 12, 1926 | 23 9 44.8 | −13 33 | +0.7 | Very good |
| 3 | 30 Psc | 23 58 11.64 | − 6 25 21.8 | Jan. 9, 1927 | 2 9 21.0 | 9 14 | +0.3 | Very good |
| 4 | 141 Tau | 5 57 17.25 | 22 24 1.5 | Feb. 11, 1927 | 23 32 54.7 | 12 23 | −0.4 | Very good |
| 5 | o Tau | 5 23 14.01 | 21 52 32.7 | Apr. 6, 1927 | 23 52 4.2 | 38 53 | +1.4 | Fair |
| 6 | ν Sco | 16 7 45.84 | −19 16 23.9 | Apr. 20, 1927 | 4 12 0.1 | 1 53 | +2.0 | Fair |

J. ERNEST G. YALDEN.

**Meteor Observed.**—At 7:15 P.M. on April 16, 1927, at Jacksonville, Ill., I saw in the eastern sky a large fireball or meteor. When first seen it was at 6° above the full moon. The object was elongated and flaring, and moved very slowly southward and downward, at the rate of about 2½ degrees per second. I saw it for about 3 seconds. There was a good deal of twilight, and the sky was quite hazy. The path was a drop of about 25 to 30 degrees angle from a line parallel with the horizon. There were no stars visible, so the moon is the only thing I have to fix the location. When I first saw it, I estimated it was about one-third again as high as the moon; but as I could not see the horizon, this is uncertain. In fact, as you will no doubt infer, all my observations were crude.

If others report this, my contribution may be of value to enable some one to determine what its actual path was.

HENRY W. ENGLISH.

## BOOK REVIEWS.

**Fogs and Clouds** by William J. Humphreys. The Williams and Wilkins Company, Baltimore. 1926, 320 pp. $4.00.

This volume by Dr. Humphreys tells the story of fogs and clouds from their source to their disappearance, it tells of Aitken's method of counting the number of particles in a given volume and gives a simple description of each of the many cloud forms and the names adopted by the International Meteorological Committee. The outstanding feature, however, is the set of nearly one hundred fine reproductions of cloud photographs. These alone are worth the price of the volume. They were taken at various places—the Antarctic, the tropics, Europe and America. The book is written in simple language so that the general reader will enjoy it. It will also be of value to all who are interested in cloud forms. It can be highly recommended. E. A. F.

**Constitution and Evolution de l'Universe,** by A. Véronnet, 480 pages with 29 figures (Gaston Doin and Company, Paris, 28 francs).

The fact that so many books are being published in all languages on various phases of astronomy may be taken as an indication of a renewed general interest in this fundamental science. This interest is heightened by the almost astounding conclusions which have been reached and published in the last few years. The present volume is the twenty-ninth in a series entitled *Bibliothèque d' Astronomie* which constitutes a part of a comprehensive encyclopedia of science. One may appreciate the size and scope of this *Encyclopédie Scientifique* by noting that there are forty sections planned comprising a total of approximately a thousand volumes.

This volume is divided into twelve chapters: The first considers the question of equilibrium of a homogeneous liquid mass in rotation; the second, a heterogeneous mass in rotation, and the shape of the earth and other planets; the third, fourth, and fifth, the equilibrium of a gaseous body under various conditions as to temperature; sixth, the maintenance of the sun's heat; seventh, the evolution of the sun and stars; eighth, the formation of a star in a nebula; ninth, the relation between the time and the temperature of formation of a star; tenth, the evolution of stellar systems; eleventh, the formation of a planetary system; twelfth, a critical study of modern hypotheses of cosmogony, concluding with a sketch of a theory based upon computations by the author himself. It seems to the reviewer that the "Planetesimal Hypothesis," which has been so well received in many quarters, should be given more consideration than is done.

The author does not hesitate to use mathematics when needed but the major part of the work is descriptive in character, and easily read by any one having the necessary facility in the French language. As a whole the book may be said to be an interesting summary of recent thought and a valuable addition to the literature of the field it is designed to cover.

**Splendour of the Heavens,** a Popular Authoritative Astronomy, two volumes, 976 pages (Robert M. McBride and Company, 7 W. 16th St., New York City, $12.50).

The descriptive title of this work is well chosen. The large number of illustrations, one or more on practically every page, justifies the word "popular," for through these pictures the volumes appeal to everyone, even in the extreme case of a person who is unable to read. On the other hand the imposing list of

names of the editors and contributors, all Fellows of the Royal Astronomical Society, is sufficient guarantee that the work is "authoritative."

To refer to all of the commendable features would result in listing all the topics discussed and all the illustrations presented. Volume I consists of ten chapters, and Volume II of fourteen, each chapter prepared by an astronomer eminently fitted for the task. The mentioning of a few of the chapter headings with the respective authors will be sufficient evidence to all who have even a slight acquaintance with astronomical literature and work, of the correctness of this statement. For example we find chapters on "The Solar System," "The Earth-Moon System," "The Asteroids or Minor Planets," "Comets," "The Ancient Constellation Figures," by A. C. D. Crommelin; "The Zodiacal Light and the inferior Planets," "Jupiter," "Falling Stars," by W. F. Denning; "The Frontiers of the Solar System," "The Calendar," by Reverend T. E. R. Phillips, now President of the Royal Astronomical Society; "The Message of Starlight," "Relativity and Gravitation," by Herbert Dingle; and a number of others.

The scope of the work is so comprehensive that one may turn with success to it for information on practically any question pertaining to astronomy, whether it relates to the distant past or to the ideas which are current at the present time. While the topics are not treated exhaustively, as obviously could not be done in two volumes for so extensive a science, nevertheless the main points are presented in a clear, concise, and masterful manner. The reviewer has repeatedly had the experience of turning to these volumes for some detail and finding himself entranced for an hour or more. Selecting almost any of the chapters, the reader will find himself as thoroughly entertained as he could be by a bit of current fiction, and he has the added advantage of being enlightened.

Anyone who desires to add to his library a comprehensive yet untechnical work on astronomy will find that these volumes will meet his expectations in a most satisfactory manner. It is at rare intervals that a work appears in which such a large amount of thought and care is represented.

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**Astronomy,** (A revision of Young's Manual of Astronomy) by Russell, Dugan, and Stewart. Two volumes, 932+ pages, 5¾x8¾ inches. Ginn & Co. 1926, 1927. Price $2.48 per volume.

This is a book that has been impatiently awaited for over twenty years. Up to the time of his death in 1908, Professor Young kept his various textbooks up to date, but since that time his larger books, the Manual of Astronomy and the General Astronomy have remained unchanged. However, on account of their excellence, both from an astronomical and from a pedagogical point of view these two books have continued in use in many colleges in preference to books of much later date.

The scope of the present revision by the successors of Professor Young at Princeton is said by the authors to be intermediate between that of the Manual and the General Astronomy.

Volume I is devoted to the elements of astronomy and the solar system. The first five chapters cover the celestial sphere, systems of coördinates, instruments, practical astronomy, the earth and its rotation and revolution. There is comparatively little new in these chapters. They have been rewritten and a few illustrations added, but the principal new matter is confind to a few pages dealing with isostacy, the constitution of the earth's interior and the age of the earth.

The discussion of the spectroscope is postponed to Volume II, so the treatment of the sun and eclipses in Volume I is purely descriptive. The chapters on

the planets, comets, and meteors follow closely the treatment by Professor Young with all the data brought up to 1926. This includes a brief account of the various theories of the origin of the solar system from Laplace down to Jeans and Jeffreys.

The greatest revision in this part of the book is in the chapter on celestial mechanics. This covers 48 pages as compared to 36 in the Manual. The new matter introduced concerns radiation pressure, ellipticity and internal condition of the planets, rigidity of the earth, tidal evolution, and relativity. Six pages are devoted to this last subject. These contain brief nonmathematical statements of the "special" and "generalized" theory of relativity and an account of the astronomical tests of the theory.

Volume II is given a subtitle of Astrophysics and Stellar Astronomy. This contains a wealth of new material, much of which has been widely scattered in periodicals and hence inaccessible to many teachers.

The first four chapters deal with the analysis of light, solar spectrum, sun's light and heat, and theories of atomic structure. Herein are discussed not only such familiar subjects as spectrum analysis, the spectroscope, spectroheliograph, photometers, photosphere, reversing layer, chromosphere, prominences, corona, and the solar constant, but also many subjects of more recent interest such as energy measuring devices, quantitative chemical analysis of solar and stellar atmospheres, magnetic field of the sun and sun-spots, energy of solar radiation, solar and planetary temperatures, electrical structure of matter, ionization and excitation potentials, origin of spectra, ultimate and subordinate lines, sharp and diffuse series, the internal constitution of the sun, age of the sun, source of solar energy, and the possible conversion of mass into energy.

The remaining nine chapters, covering 340 pages, are devoted to the stars and nebulae. Of special interest in these chapters may be mentioned the discussion of star streaming, mass-ratio, mass-luminosity curve, dynamical parallax of double stars; luminosities, temperatures, and diameters of stars, theory of the interferometer, giant and dwarf stars, problem of the white dwarfs, Cepheid and cluster variables, period-luminosity curve, and the pulsation theory; distribution, dimensions, and distances of star clusters; shape and dimensions of the Galaxy, the "local system" and the limits of the universe; dark nebulae, theory of the light in bright nebulae, variable nebulae, and "island universes"; stellar atmospheres, the interior of the stars, source of stellar energy, theories of stellar evolution, the dissipation of energy, and the possible fate of the universe.

The work as a whole is remarkably well written. I have noticed only about a dozen slight slips, most of them perfectly obvious, as for example, earlier for later, line 3, page 27, and the omission of the word product in the statement of the law of gravitation at the top of page 124.

As a textbook I consider it well adapted to the average college beginners' class in descriptive astronomy. The first third of Volume II will be heavy reading for those not well grounded in physics, and, in some chapters, the more technical matter in fine print may have to be omitted for lack of time. These sections, however, add greatly to the value of the book for reference.

It is not a book for casual reading, but a book to be studied and discussed, a book which will make both the student and the professor think. We find here not a mere catalogue of dry facts, but rather a discussion of subjects that are alive, growing and changing. This is especially true in Volume II, where the emphasis is primarily upon the methods of attacking the problems, the results obtained and the explanations and theories suggested.

Of theories there are many and at the end of a statement of a theory we frequently read "but here again we are on the edge of the purely speculative," or "this is still in a state of flux and conclusions which today are thought to be well substantiated may be overthrown tomorrow."

The following quotations will indicate the authors' opinions in regard to a variety of questions of current popular interest:

Page 308. "The astronomical evidence, which alone affords an observational test to the general theory of relativity, is therefore at all ponits definitely in its favor."

Page 344. "The observations of the last few years make it very probable that conditions on Mars are such that vegetable life of the sort that exists on the earth might exist there, and at the present time (1926) it seems more likely than not that it does." . . . "That animal life should also exist is not impossible, or, indeed even improbable."

Page 592. "At the present rate of loss of mass by radiation the sun, during the past billion years, has lost only one-fifteenth thousandth of its whole mass, and it is improbable that its size or other characteristics have changed perceptibly in that interval. Its whole life as a luminary has probably endured for thousands of billions of years; and the sun is likely to shine, with gradually decreasing splendor, for even longer in the future."

Page 764. Referring to the period-luminosity curve for Cepheids: "Why this remarkable relation should exist is not yet explained, but the evidence that it actually does exist is very strong."

Page 767. Referring to the theory of Cepheid variation: "Qualitatively therefore, the pulsation theory accounts satisfactorily for the phenomena."

Page 813. "But it does show that the dimensions of the region within which they (the stars) are thickly strewn must unquestionably be finite."

Page 822. Referring to dark nebulae: "There appears to be little doubt that the main obscuring agent in these clouds is *fine dust.*"

Page 857. "The term 'island universes' (which has often been used to describe the spiral nebulae) appears, therefore, to be well chosen."

Page 894. "The characteristics of the stars depend upon the simplest and most fundamental laws of nature, and even with our present knowledge might have been predicted from general physical principles if we had never seen a star."

Page 929. "It is natural to suppose that at a still earlier stage the matter which later formed a star was cold and dark, and perhaps widely scattered through space."

Page 929. "The final state of a star, so far as it can be followed by observation, is illustrated by the companion of Sirius,—small, exceedingly dense, and with the ionized atoms crowded almost into contact."

Page 932. "If, in some way still unknown to us, matter is formed again out of radiant energy, a vast process of unending change may go on forever. What we know so far exhibits the processes of nature as irreversible, and makes the dissipation of energy appear inevitable; but our knowledge of nature is limited, and any answer to questions of such scope as this must at present be purely speculative.

"It may be that at the last dissipation will be complete, and the end will come with 'darkness upon the face of the deep,' or, instead, that in some way there may arise 'a new heaven and a new earth,' perpetually renewed; but which hypothesis is true our present science cannot tell."

FREDERICK SLOCUM.